INSTRUMENTS and AUTOMATION

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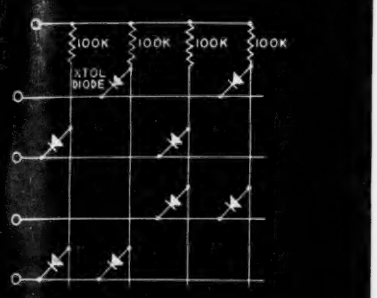
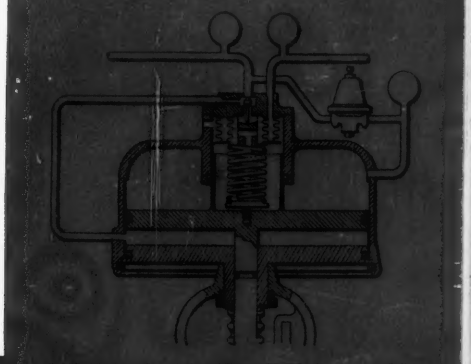


'AL PROCESS CONTROL - - - 1979



CYLINDER POSITIONERS - - - 1986

PROCESS COMPUTER - - - 2028

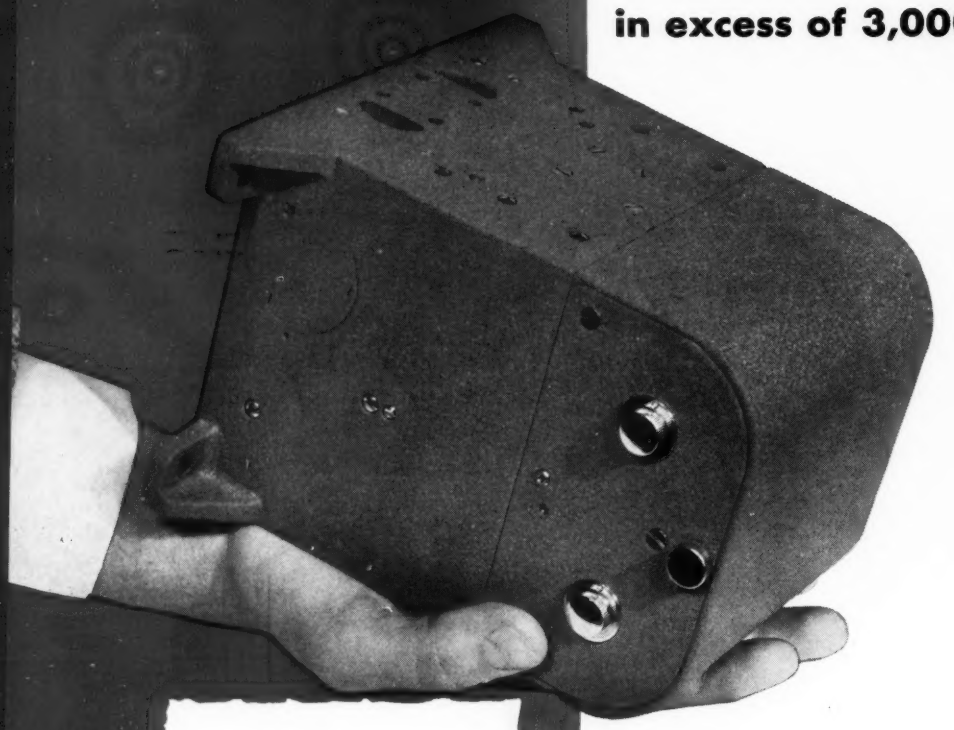
Part I of two parts
OCTOBER 1956

THIRD INTERNATIONAL AUTOMATION EXPOSITION

EXHIBITORS and PRODUCTS
- - - - 2027

the MIDWESTERN 560B OSCILLOGRAPH . . .

designed and tested to withstand shock accelerations in excess of 3,000 gravities . . .



This miniaturized 14-channel oscillograph has been subjected to extremely high shock accelerations and by the use of shock-delay techniques, has recorded all data associated with them. Some of its many features are — $3\frac{5}{8}''$ x 50 foot record capacity • $\frac{3}{8}$ to 8 inches per second recording speeds • ability to record while subjected to constant accelerations of 20 gravities • $5\frac{3}{4}$ x $6\frac{5}{8}$ x $7\frac{1}{16}$ inches overall dimensions • operated from 28 volt dc power sources.

other midwestern products

- OSCILLOGRAPHS (Laboratory and Flight Test)
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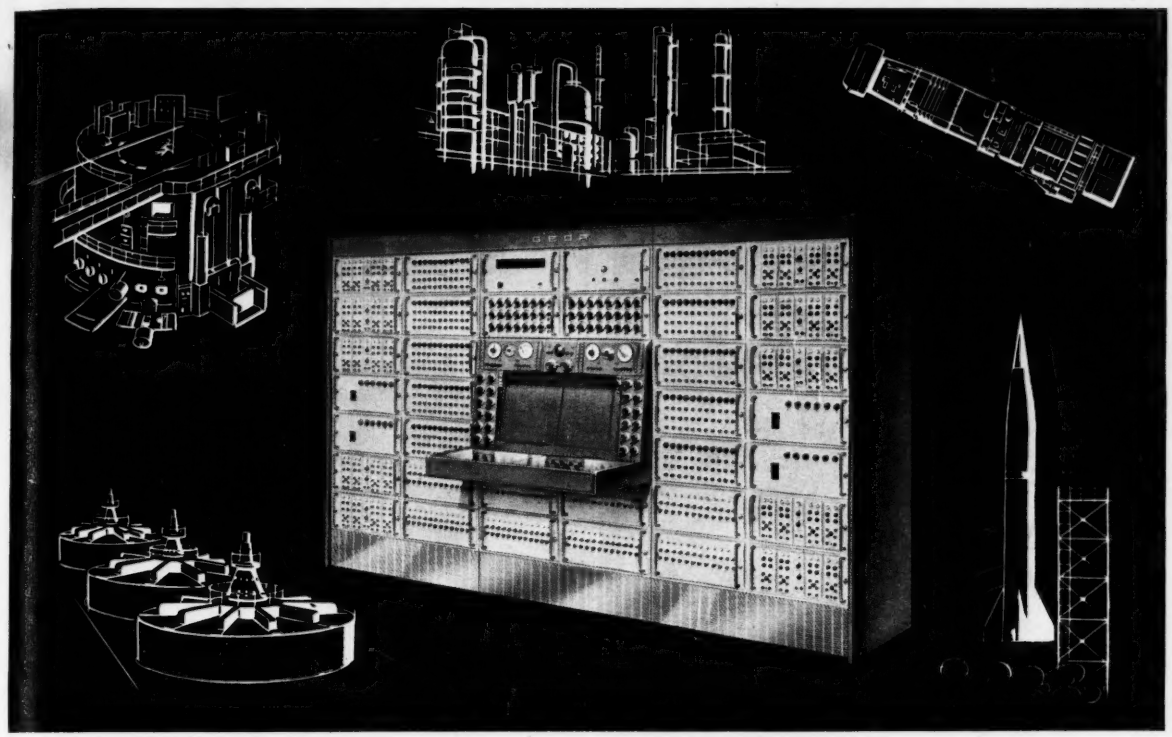
For more information circle **1** on inquiry card.



among the problems we can solve for you...

nuclear reactor simulation
jet engine simulation
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flight & guidance simulation
power dispatch simulation

No matter which of these categories describes your engineering problems, there's a GEDA A-14 Electronic Simulator custom-designed to save *you* precious engineering man-hours.

These spectacular new electronic simulators present the first commercially available console operated analog computing systems individually designed to *specific* simulation problems. Available with as few as twelve, to as many as several hundred amplifiers — plus hundreds of nonlinear channels — these GEDA A-14 Electronic Simulators offer precision, flexibility, convenience and stability heretofore unknown in commercial installations.

With built-in features you cannot obtain even as options on other computers, the new GEDA A-14 Simulators offer the most accurate, widest band-width linear computing equipment *plus* the most precise high-speed, nonlinear equipment in the industry. And, with the new GEDA A-14, you have the widest selection of accessory equipment available.

Exclusive features such as Automatic Read-Out Printing, Automatic Dialing System, the unique split problem board for analyzing two separate problems simultaneously and many more, make the new GEDA A-14 the most advanced, most flexible analog computing systems ever offered to industry. And, you get these custom-built features at production economy.

We would welcome the opportunity to discuss the details of a GEDA A-14 installation — large or small — custom-designed to *your* exact requirements. Write: Goodyear Aircraft Corporation, Dept 931EV, Akron 15, Ohio.

• • •

Now available is a new Goodyear Engineering Report, GER-7648, which describes the principles of operation of the GEDA A-14 Nuclear Reactor Simulator. Write now for your copy.

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ANALOG COMPUTERS

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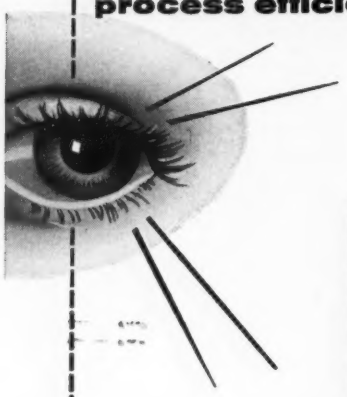
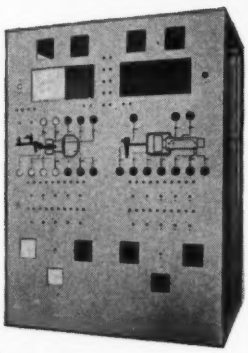
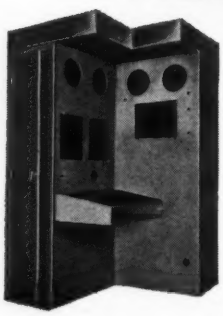
"VISIONEERED" panels and control boards help improve process efficiency







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Falstrom's "visioneered" construction gives you exactly what you envisage. Put Falstrom "visioneering" to work for you in accurate mountings of any size, in any metal—at low cost.

Write for Falstrom catalog of standard panels and control boards 143A or send prints and requirements for prompt estimate.

FALSTROM

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For more information circle **3** on inquiry card.

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THE *Versatile* UNIVERSAL 88 POLYRANGER

88 FULL SCALE RANGES. **DC — 200 microamps. to 1.5 amps., and 5 M.V. to 750 V. AC — 10 M.A. to 3 amps., and 500 M.V. to 750 V. .5% accuracy. For use up to 5 kc. on voltage and 15 kc. on current. 5.2" hand drawn mirrored scale. Automatic temperature compensation.**

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14 FULL SCALE RANGES. **DC—1.5 M.A. to 10 amps., and 1 V. to 1000 V. Two combinations. .25% accuracy. 6.3" hand drawn mirrored scale.**

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INSTRUMENTS and AUTOMATION

Volume 29, No. 10
October 1956

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Editorial

A New Concept 1965

ISA Show Highlights 1965

Some Conference and Show "Firsts" 1967

Wescon Highlights 1968

Special Feature

Third International Automation Exposition—Exhibitors and Products 2027

Feature Articles

Digital Process Control 1979
Martin Klein, Frank K. Williams and Harry C. Morgan

Electron Photography 1985

Positioners for Cylinder Actuators 1986
C. S. Beard

Electronic Circuitry 1992
Milton H. Aronson and Charles F. Kezer

Measurement of Short Time Intervals 1994
F. K. Priebe and H. D. Tanzman

Iron & Steel⇄Instrumentation 1998

Process Control and the Analog Computer 2000
Joseph L. Hussey

Journal of the Southern California Meter Association

Economic Aspects of Process Control 2006
William C. Gardner and John E. Leary

The Simulation Council Newsletter 2015

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL FOR 28 YEARS – SINCE JANUARY 1928

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INSTRUMENTS and AUTOMATION

Letters to the editor

Editor, I&A:

The Valve Positioner article in the Sept. issue of I&A is a fine job that has needed doing for some time. There's just one thing: the Foxboro model you've described is our Type B which is gradually being superseded by our Type C, which was announced at last year's ISA Show.

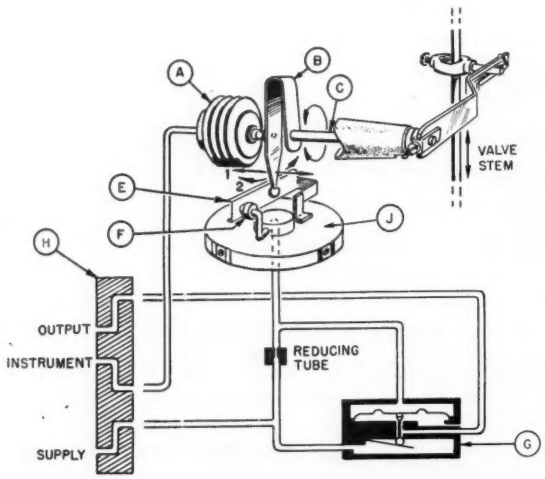
B. A. Chase
Control Valve Sales
The Foxboro Company
Foxboro, Mass.

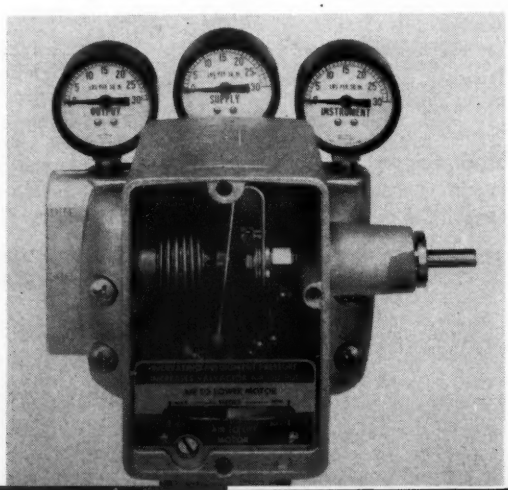
The following description of the newer Foxboro Type "Vernier Valvactor" valve positioner should have been included in that article. "Better late than never."

Type C Vernier Valvactor

The "Type C Vernier Valvactor," like the Type B described previously, is a position-balance valve positioner, but is gradually superseding the Type B.

It has the same elements—(1) bellows that receives the instrument controller signal, (2) flapper-nozzle unit that controls a pilot relay, and (3) mechanical feedback from the valve stem that repositions the flapper to neutral position when valve stem position is as called for by the instrument signal. For yoke-mounting application, the Type C has a minimum of moving parts and can be easily adjusted to suit all valve actions by rotating a disc—no interchanging of components. Space requirement is considerably less with the new model.





The Type C Vernier Valvactor. Top, elements and operation; bottom, appearance.

Editor, I&A:

Several articles have been written on the subject of computers in your *Instruments and Automation* magazine. These articles are of great interest to us at the present time.

We are in a process of securing an analogue computer for ground testing and analysis of our automatic flight controls for jet aircraft. Your articles have aided us in establishing some criteria for evaluating the computers which we are considering purchasing. However, we would like to know if you have available, under separate cover, a complete series of articles dealing with analogue and digital computers.

J. Tragarz
Flight Test Engineer
Minneapolis-Honeywell Regulator Co.
Aeronautical Div.,
Minneapolis, Minn.

The *Computer Handbook*, First Edition, is what you are looking for—it contains a complete series of article on both analog and digital computers. The Second Edition, an expanded edition, will be ready in the near future.

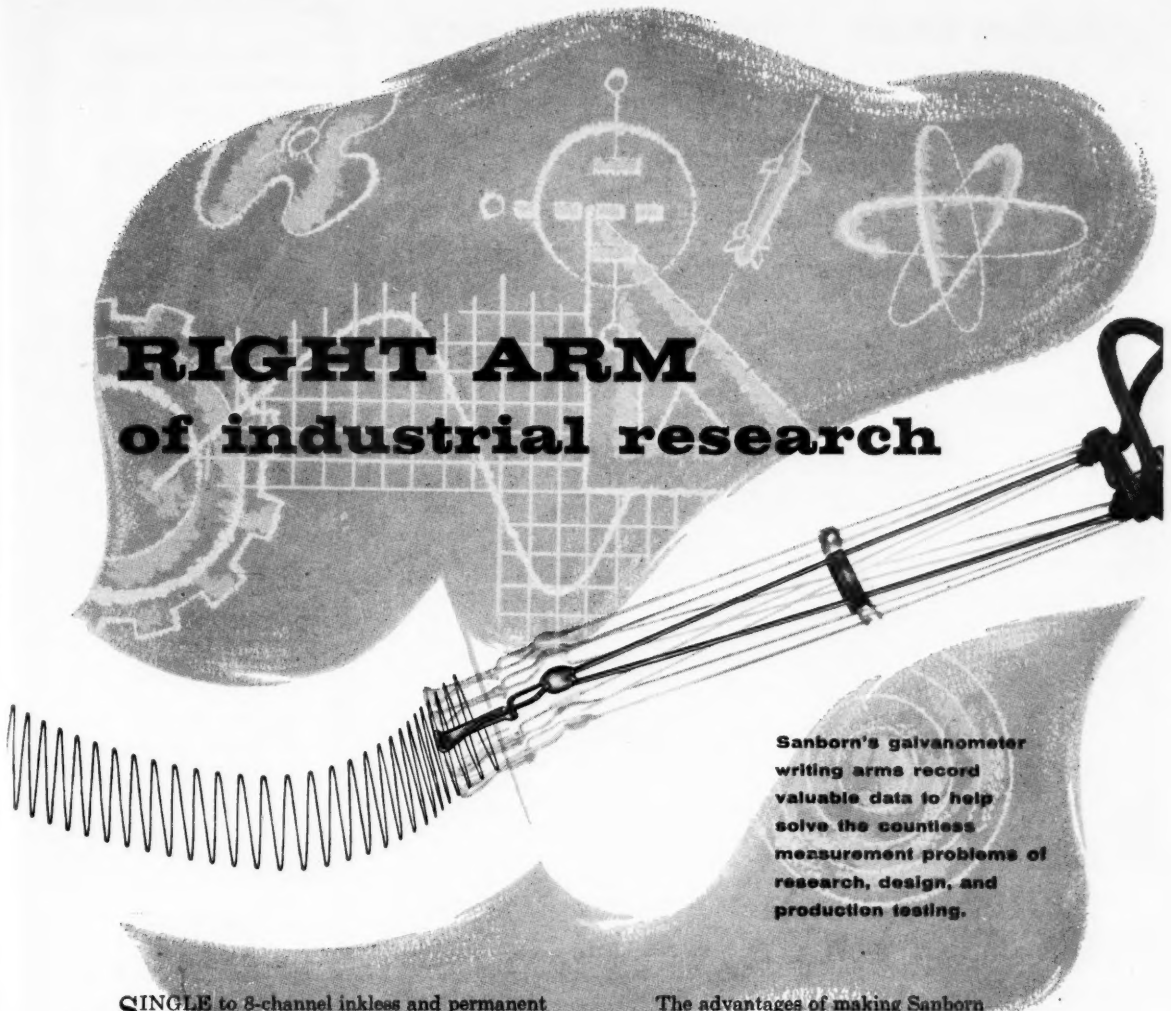
Editor, I&A:

I recently received the reprints of the first eight articles on "Digital Automation" that you are forwarding to prospective subscribers. I find this reprint to be very applicable to the work now going on in the organization to which I am attached. In fact, your timing was perfect and as a result I am enclosing my order for a three years' subscription to *Instruments and Automation.*

However, there are several other people in the Air Force Armament Center that would benefit highly from this reprint and from your publication. Therefore, I am taking the liberty of enclosing a list of their names and business addresses in the hope that you will send them copies of "Digital Automation" reprints. All of these people are engineers and engineering managers directly or indirectly associated with the development of Digital Data-Handling Systems for the Air Force Armament Center's elaborate test range instrumentation system. Please feel free to use my name as the one who recommended your sending the reprints to them.

Richard E. Marsh
Fort Walton Beach
Florida

Thus does news circulate. Requests for this material now exceed the thousand mark.



RIGHT ARM of industrial research

Sanborn's galvanometer writing arms record valuable data to help solve the countless measurement problems of research, design, and production testing.

SINGLE to 8-channel inkless and permanent recording in true rectangular coordinates of 0-100 cps phenomena — ranging from telemetered aircraft data to atomic reactor characteristics — is the vital and growing role of Sanborn oscillographic recording systems in industry. The Sanborn file of users indicates that such recordings are aiding in the dynamic analysis of jet engine starters, machine tools, agricultural machinery and oil drilling equipment; performance of pilotless target aircraft, modern submarines and tracking radar systems; and the production testing of servo components, valve positioners and precision potentiometers. Sanborn systems designed especially for recording analog computer output extend applications further — in simulated flight set-ups, solution of complex problems with six or eight variables, etc.

The advantages of making Sanborn equipment the "right arm" of *your* recording problems include extreme *flexibility*, by means of a dozen different interchangeable, plug-in "150 Series" preamplifiers which quickly and economically adapt a basic system to changing requirements; choice of 1-, 2-, 4-, 6- or 8-channel systems, in vertical mobile cabinets or "portably packaged"; numerous chart speeds, many individual channel controls, and high over-all system linearity.

To see how oscillographic recording the Sanborn way can become the "Right Arm" of *your* analysis work, write for detailed information or contact your Sanborn Representative. Sixteen-page "150 System" catalog on request.

SANBORN COMPANY
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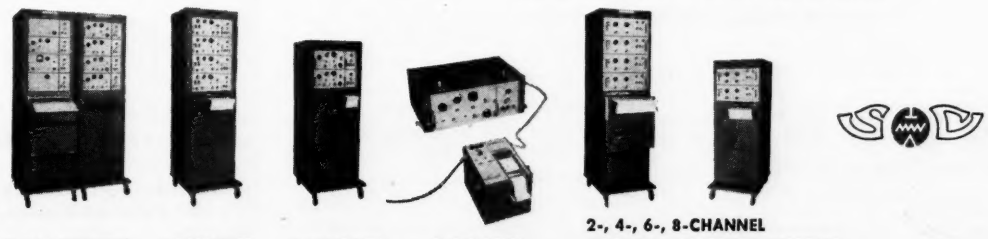

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LETTERS—CONTINUED

Editor, I&A:

On Page 1082 of Volume 29, the June issue, under "1955 Reports," it is stated "Minneapolis-Honeywell Regulator 1955 Sales—$19,000,000."

Of course anyone familiar with the amount of business done by Minneapolis-Honeywell would realize that this figure was entirely wrong for 1955 sales. The actual figure as taken from the Minneapolis-Honeywell 1955 Annual Report was $244,482,-068.

Richard P. Brown
Philadelphia 2, Pa.

Our editorial slip consisted of using the word "sales" instead of "earnings." Minneapolis-Honeywell reported $244,482,068 *sales* and $19,278,648 ($4 million over 1954) *earnings* in 1955. What's $220 million between friends?

Editor, I&A:

Your article "Practical Analog-Digital Converters" in the June 1956 issue of *I & A* was most informative but may have, unknown to the authors, created a misimpression in the minds of your readers.

A list of converters was supplied and referenced in the text as follows: "As shown in the following listing of available converters . . ." By neglecting the use of the word "some" before "available converters," it appears that the appended list is exhaustive. There are, however, other commercially available analog-to-digital converters with proven performance records that offer features of interest to potential users.

B. H. Manheimer
The Austin Co.
Special Devices Div.
New York 11, N. Y.

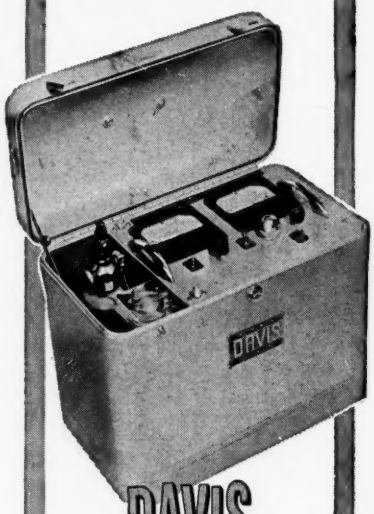
We slipped up in forgetting about the Austin Shaft Position Quantizer. The following material should have been included with the induction-type digital converters in No. 9 of the Digital Automation series:

The Austin Company

The Austin Company "Shaft Position Quantizer" provides a readout in pulse form proportional to the position of the input shaft, at any preset times (up to 60 per second) regardless of whether the input shaft is standing still or rotating.

Direct coupling to the input shaft, with no gears used, eliminates chances of mechanical errors due to backlash or other gear errors.

Measures oxygen and combustibles simultaneously!



DAVIS PORTABLE COMBUSTION TESTER

A double duty portable precision instrument for the analysis of exhaust gases in varied combustion processes. Oxygen and combustibles measured and indicated on separate meters simultaneously. A Davis representative will gladly arrange a demonstration at your plant.

Size: 18" x 12" x 18"
Weight: 40 lbs.
115V, 60 cycle operation

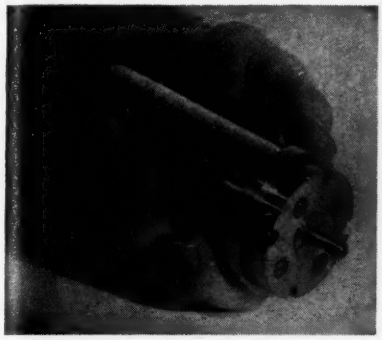
Send for Bulletin 11-34

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS
Division of
Davis Emergency Equipment Co., Inc.
80 Halleck Street, Newark 4, N. J.

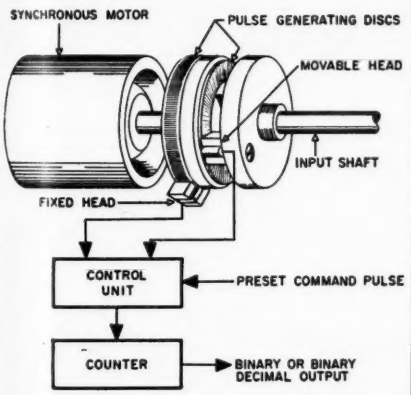
For more information circle 7 on inquiry card.

The 3600-rpm synchronous motor revolves the two engraved pulse-generating discs, rigidly coupled together, past a fixed head and a movable head (controlled by the input shaft). As the discs have 500 divisions which generate pulses by induction, 30,000-pps signals are sent to the control unit. In the control unit the frequency is multiplied eight times, creating a resolution of 1 in 4000 parts—with



no gearing or changing of rotors.

When a command pulse is received, the control unit compares the positions of the two heads by generating a train of pulses directly proportional to this displacement. A count of these pulses provides an output of shaft position at the instant of command in binary, binary decimal, or other convenient form.



Exact time of readout is established in the unit to within ±2 microseconds of the time of the command pulse. Controlled readout time and accuracy of measurement of successive shaft positions allow for precise velocity and acceleration calculations. Variations include the number of counts per turn of the shaft, variations in means of readout and control, and combinations of the quantizer with other system elements such as synchros.

Now an *entire* railroad can be controlled from one central point

Traffic control engineers have long dreamed of being able to control an entire railroad from one central point. Today, the equipment has been developed at Union Switch & Signal that will do this job. Operators with modern Union Centralized Traffic Control systems, can now direct train movements by signal indications on 100, 500, 1000 or more miles of single or multiple-track railroad.

What is your control problem?

Union Switch & Signal engineers are applying experience gained from designing installations of control systems covering 25,000 miles of railway—to industrial applications. They have developed centralized control of pipelines, control of steel mill soaking pit doors from traveling cranes, control of TV tower elevators without wired connections between cab and motor controller. Other systems and devices such as flight simulators, and guided missile ground handling equipment are part of their daily work. These men can help you in various phases of industrial automation. Write us about your problems.

GENERAL APPARATUS SALES

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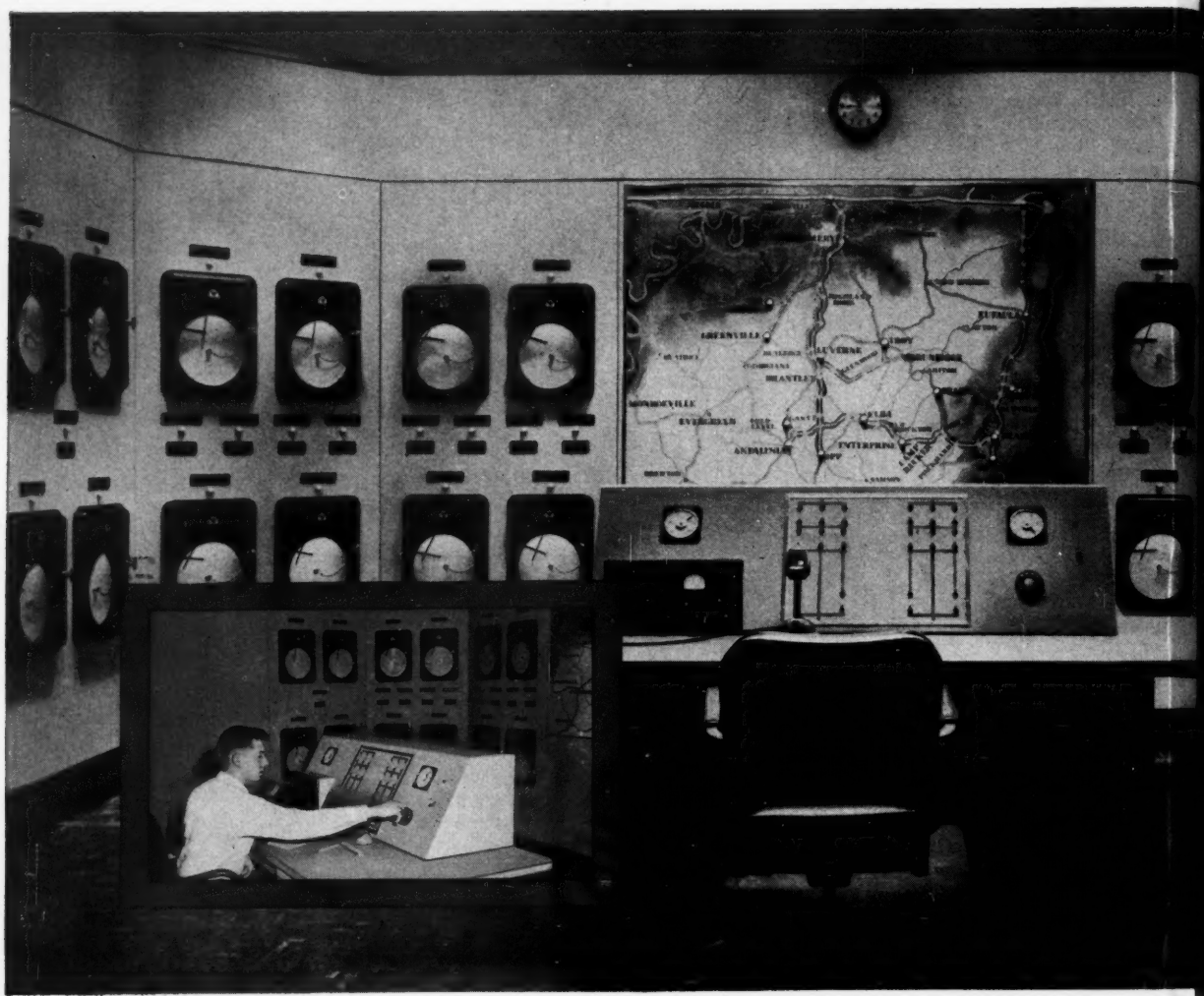
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18 PENNSYLVANIA

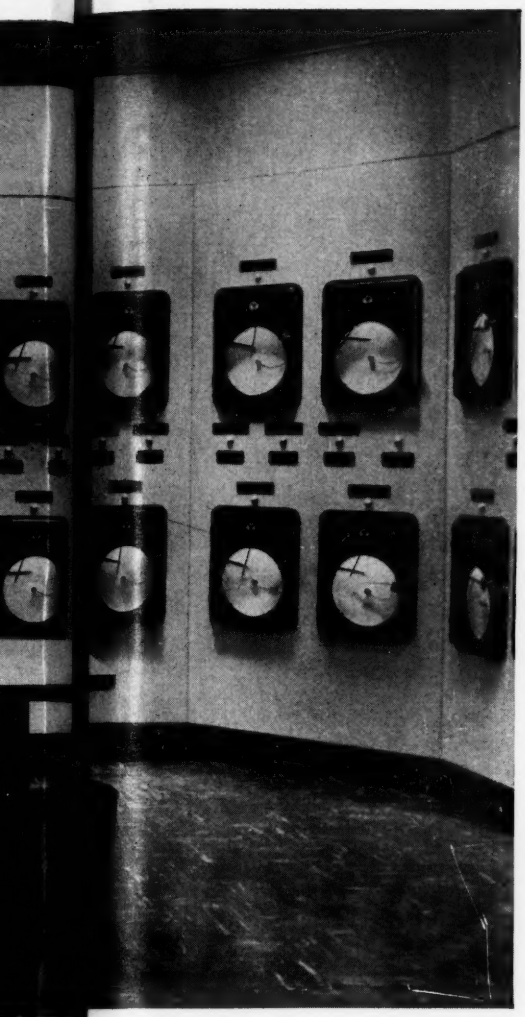
For more information circle 8 on inquiry card.



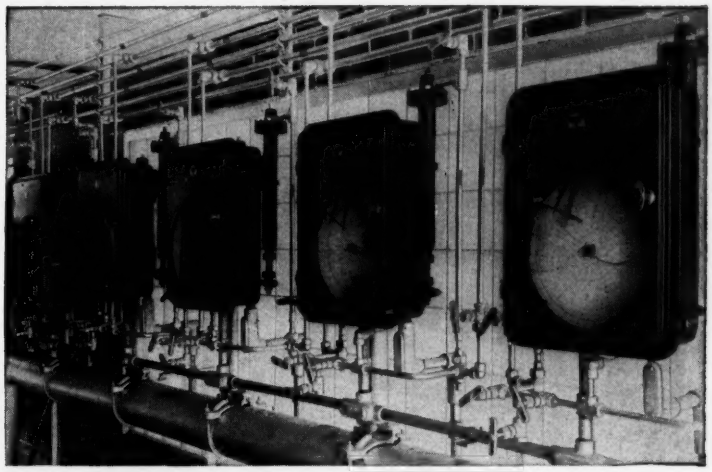
Remote Control of Flow and Pressure for 24 cities and towns in Alabama

ANOTHER ALL AMERICAN® INSTALLATION — From a centrally located desk in Andalusia, Alabama, one dispatcher, by remote control, regulates the flow of gas for the 24 cities in the Southeast Alabama Gas District—largest municipal natural gas system in the world. The 120 years engineering and precision manufacturing experience of American Meter Company assisted by supplying equipment for this new type modern gas measurement and control installation to bring the advantages of natural GAS to one of the fast-growing areas of the United States.

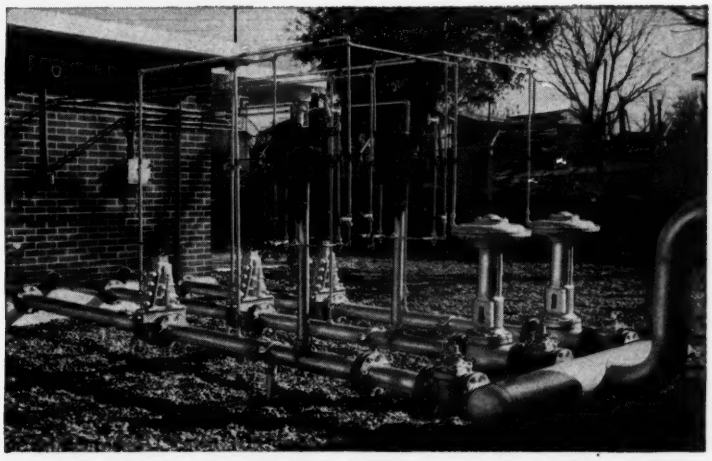
For more information circle 9 on inquiry card.



DISPATCHER STATION – By dialing a single circuit, dispatcher obtains total flow in cubic feet and pressure from each of the 14 city gate stations, plus total flow in cubic feet, pressures and differentials of orifice meters and controllers at each intake station to permit complete remote dispatching.



INTAKE STATIONS – All measurement at intake stations, 90 miles and 120 miles from dispatcher's desk, is combined in a totalizing relay which in turn is put on a memory relay to supply total flow since last dialing.



CITY GATE STATIONS – Each station has American automatic measurement, pressure and regulation equipment, totalizing relays and memory relays, enabling dispatcher to obtain flow for any period and obtain pressures. Complete remote control of dual flow differentials, dual first and second stage regulators.

HIGH PRESSURE RURAL SERVICE REGULATORS

AMERICAN®
METER COMPANY
INCORPORATED (ESTABLISHED 1836)

GENERAL SALES OFFICE: Somerton, Philadelphia 16, Penna. • Albany • Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie • Houston • Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle • Tulsa • Wynnewood
IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton • Regina

SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters • Instruments • Reliance Regulators • Apparatus • Valves

For more information circle **9** on inquiry card.

New!

IDEAL SURVEY METER FOR RADIATION SAFETY

- **Compact, convenient, accurate**
- **Operates on a single flashlight cell**
- **Weighs only 2 pounds**
- **Beta or gamma by twist of a knob**
- **Two ranges: 0-25 mr/hr, 0-1 r/hr**
- **Accessories to multiply or divide both ranges by 10**

Curtiss-Wright

RADIAMETER

The Curtiss-Wright Radiameter is a radiation survey meter designed especially for health physics and industrial hygiene applications. Using a unique inverted triode circuit, it performs functions usually requiring two instruments. The lower scale provides high sensitivity for decontamination monitoring. The high scale measures stronger radiation fields usually requiring an ionization chamber type instrument.

Where other radiation survey meters require several expensive and hard-to-find batteries, the Radiameter is powered by a single inexpensive flashlight cell. It is easy to handle and slips readily into a suit coat pocket.

Having the appearance of a light meter or camera, it attracts minimum attention from plant personnel during safety checks. The one-piece cast aluminum case is light in weight, but extremely rugged and waterproof. The Geiger tube or battery may be changed in seconds and without tools. Controls are simple, even for non-technical personnel, and the meter is easy to read.

Accuracy is ±10% of full scale on both scales for energies from 50 to 1,200 kev. The Radiameter is useful for monitoring energies as low as 15 kev. In the presence of radiation of high intensity, the instrument does not overload but continues to read off-scale. It can be zeroed even in a strong field. Its fast response permits monitoring x-ray installations turned on only momentarily. Battery life is long—approximately 140 hours.

Available accessories include a probe to multiply sensitivity by 10, a tube to divide sensitivity by 10, an alpha tube, a radium calibration source, a push-button on-off switch, and an attractive leather carrying case. Write for details.

Component and Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

For more information circle **10** on inquiry card.

LETTERS—CONTINUED

Editor, I&A:

We have heard so many nice things about you from your space representatives—extolling the extent of your intelligence, praising your unflagging enthusiasm for furthering the cause of science, and expressing their pride in your greatness of heart for encouraging small but sincere endeavors for improving the industry—that we are emboldened to submit for your perusal our own timid effort to produce a periodic publication.

Although we assure you that you need not fear competition from our paper, perhaps it might be well if you knew of its existence, and, in view of the sweetness of soul which your representative assures us you have, we feel that we can rely on you for guidance and encouragement.

Hoping to receive your charitable opinion of this little effort, we remain

Anthony A. Blundi,
Publisher of THE WORD
Burroughs Corporation
Philadelphia 7, Pa.

We consider this literary effort—*The Word*—of more than passing importance. It has already become a "dapifer" enlightening us about "burking," and we predict success for this little journal of dual function—enlarging the vocabulary of engineers while mentioning Burroughs Pulse Equipment, in passing as it were.

Editor, I&A:

I have read with interest the article on Dr. Axel H. Peterson in the March issue of *Instruments and Automation.* My interest was immediately drawn to the paragraph on "Instrument Rental Service."

There is one aspect which I do not quite understand, and that is what is meant by "Fellowships."

Leo Scharry
Professional Engineer
Alta Instrumentation & Metering Co.
Montreal 12, Quebec

Doctor Peterson replies as follows:

Mr. Aronson has referred your letter to me for an answer. Our definition of a fellowship is as follows:

A fellowship for research in pure or applied science, according to the Institute's investigational system,

represents the bestowal, on a scientist or upon a group of scientists, of a grant for research, of the rights and privileges of Institute membership, of the advice of the organization's executive staff, of the cooperation of other members, and of the use of the Institute's facilities.

Mellon Institute operates by means of contracts with Fellowship Donors for specified periods of time, which are required to be of at least one year's duration, with the full-time services of at least one scientist on each Fellowship. Only problems of fundamental importance or of real significance to science and industry are accepted for study.

Thus a manufacturer, seeking to investigate a major problem or hoping for general benefit from a planned scientific research program, may execute a contract with the Institute, provided that the proposed field of investigation is one in which the application of the natural sciences —particularly the chemical sciences —offers hope of success, and also provided the field is one not already under investigation in the Institute. Here only one research project or Fellowship in any given field is operated at a time; hence there is no conflict between Donor interests with the Institute, and cooperative association among the individual research specialists is encouraged at all times. All results of the research of a Fellowship are the property of its Donor.

Axel H. Peterson, Head
Department of Instrumentation
Mellon Institute of Industrial Research
University of Pittsburgh
Pittsburgh 13, *Pa.*

Editor, I&A:

The Los Angeles County Board of Supervisors is looking for new methods of tallying votes . . . including consideration of the use of electronic or electro-mechanical devices to tally votes. We are inviting competent manufacturers to submit bids on the development of prototype equipment.

Arthur J. Will
Chief Administrative Officer
County of Los Angeles
Board of Supervisors
501 *Hall of Records*
Los Angeles 12, *California*

Editor, I&A:

We have had wonderful response to your insertions covering our products; in fact, your magazine has given us the top quota on sales leads.

Iris Becker
Sales Promotion
J. B. Rea Company, Inc.
Santa Monica, Calif.

USG

YOUR PRIME SOURCE

...FOR *Every* TYPE OF GAUGE

From quality cast case gauges to standard steel case gauges, United States Gauge is your prime source for any type gauge, for any application. The industry's most complete line—more than 50,000 different standard gauges —is available for such applications as panel boards, compressors, pumps and process control. With slight modification, many of these standard gauges will meet special design requirements.

Why not call either the nearest USG Distributor or USG field office, or write the factory . . . Gauge Headquarters for over 50 years.

USG UNITED STATES GAUGE

Division of American Machine and Metals, Inc.
Sellersville, Pa.

Home of the SUPERGAUGE

For more information circle 11 on inquiry card.

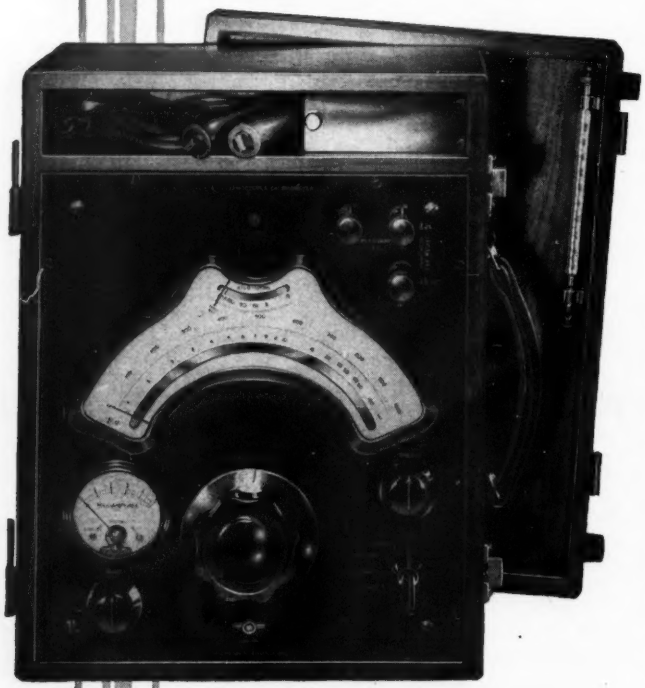
AN ACCURATE, PORTABLE, MULTI-FUNCTION INSTRUMENT

THE LEWIS *PORTABLE* TEST POTENTIOMETER

for Service Testing Exhaust Temperature Measuring Systems

Developed for use by field service engineers of a leading engine manufacturer, the Model 13P05 Test Potentiometer has proven its serviceability in desert heat and arctic cold at maintenance bases on many points of the globe.

FOUR PRECISION INSTRUMENTS IN ONE!



Model 13P05

For dependable maintenance, use test equipment made by the manufacturer of the components to be checked.

A PYROMETER-POTENTIOMETER for measuring exhaust thermocouple temperatures that is truly portable with a sturdy pivoted galvanometer and without a standard cell. Accurate automatic electrically operated cold junction compensation permits this instrument to be used in ambient temperatures from below freezing to plus 120°F. Mirror scales with precise hand-drawn graduations and knife edge pointers insure accurate readings from zero to 1000 degrees Centigrade.

A LOW RANGE OHM-METER with a widely spaced, hand drawn scale for checking the resistance of leads, thermocouples and balancing resistors to insure correct adjustment to match external resistance requirements of exhaust temperature indicators, either eight or twenty-two ohms.

A KILO-OHM METER, energized by a 67½ volt battery for checking insulation resistance of lead-wires and thermocouples. Due to the potential applied, this circuit is more effective in detecting flaws than conventional ohm meters. A hand-drawn scale is clearly marked in kilo ohms resistance.

A THERMOMETER TESTER for precise scale error checks of exhaust temperature indicators having either eight or twenty-two ohms external resistance. A controlled power supply energizes the indicator under test, through the correct series resistance, and the zero to 1000°C temperature scale is used as a reference standard. Recommended for use in adjusting exhaust indicators in accordance with ambient temperature, with power applied for 700°C, through the proper resistance. A liquid-in-glass thermometer and flexible test leads are supplied with each instrument.

LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

For more information circle **12** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Industrial research is one of the fastest growing industries of today. Whereas economy is growing at rate of about 3% per year, industrial research has tripled in size every ten years since 1930—from about $300 million in 1930 to about $1 billion in 1940 to about $3 billion in 1950, and is expected to exceed $5 billion in 1956, reaching nearly 1% of the total gross national product. The industry now employs about 500,000 persons. Significance is that research leads to new products, new industries, and is founded on a base of instrumentation. Trend is to integrated team-work research activities with ever-growing emphasis on instrumentation.

Comparison of 1955 and 1945 National Income by major industrial divisions, (billions of dollars) shows strength of manufacturing, trade, and services; weakness of agriculture. Note large percentage decline in government income.
(Source: Office of Business Economics, U. S. Department of Commerce, July 16, 1956.)

	1955		1945	
	Amount	Percent	Amount	Percent
All industries, total	324.0	100.0	181.2	100.0
Manufacturing	101.8	31.5	52.0	28.7
Wholesale and retail trade	55.0	17.0	28.0	15.4
Government and government enterprises	37.7	11.6	36.8	20.3
Services	32.5	10.0	14.6	8.1
Finance, insurance and and real estate	29.5	9.1	12.8	7.1
Contract construction	16.6	5.1	4.3	2.4
Agriculture, forestry and fisheries	16.0	4.9	14.9	8.2
Transportation	15.9	4.9	10.5	5.8
Communications and public utilities	11.5	3.6	4.2	2.3
Mining	5.6	1.7	2.7	1.5
Others	2.0	0.6	0.4	.0.2

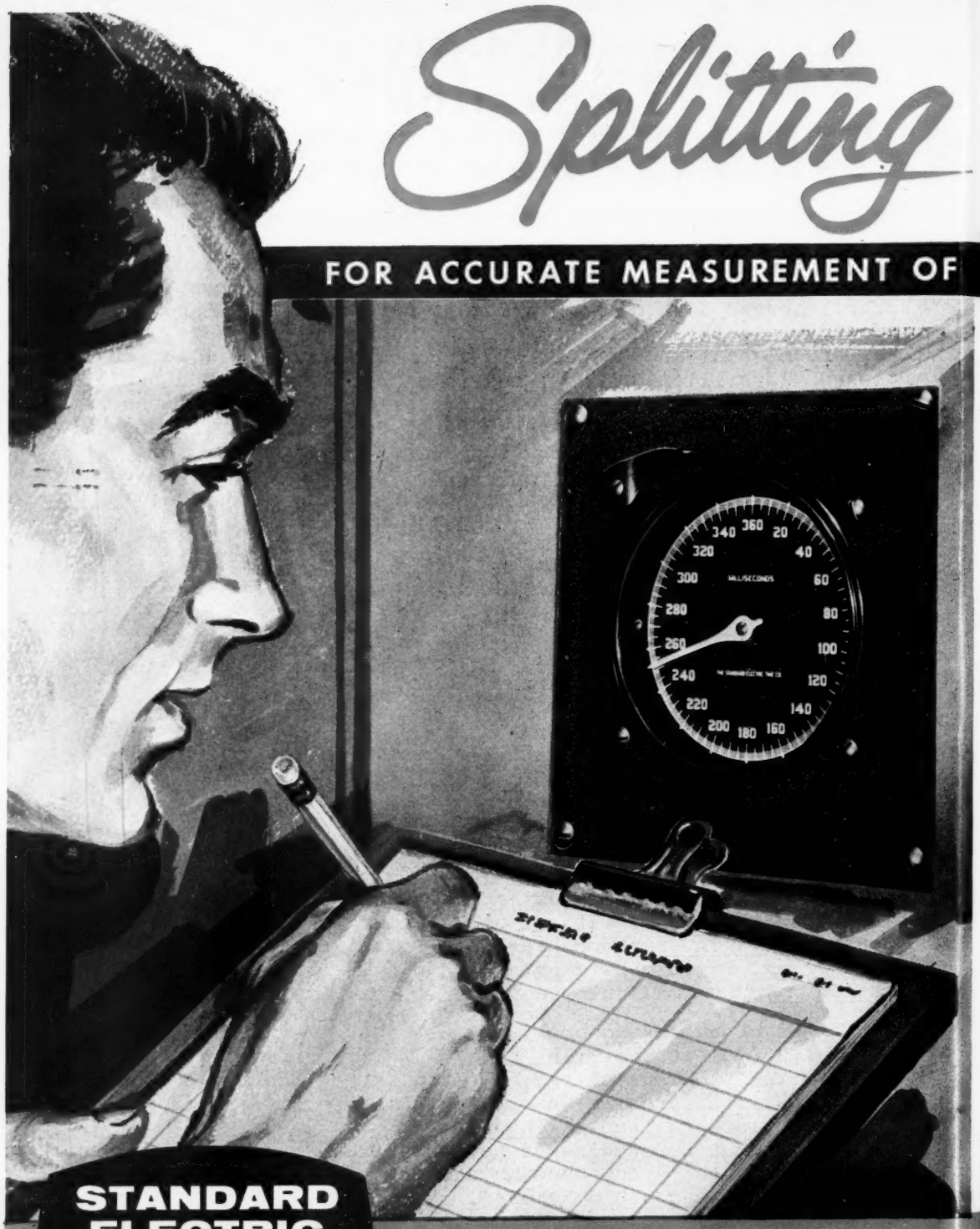
Research and development costs revealed by informal survey by Westinghouse of several atomic-power research and development labs shows that about 37% are on metallurgical problems, 28% on mechanical engineering problems, 11% on electrical and electronic engineering, 7% on chemistry and chemical engineering, 6% on operation and test. All involve extensive instrumentation.

Types of engineers employed in these labs are 25% mechanical, 22% electrical, 15% physicists, 14% chem and chem engineering, 10% metallurgy, 4% mathematics. Only 10% had doctor degrees. Surprising result: only handful of men considered themselves nuclear engineers.
Only about 500 engineers have received formal nuclear training to date; about 5000 have been trained "on the job." Four times as many could be used.

Outstanding developments in the field of general aviation (all types) in past 10 years, reports CAA, is shift from instructional and pleasure flying to commercial airline and business and industrial transportation. Total hours flown in 1954 in general aviation was 8.8 million hours, and is predicted to reach 14 million hours by 1965. Business flying is expected to increase from 4 million hours in 1954 to 7.5 million in 1965.

Splitting

FOR ACCURATE MEASUREMENT OF



STANDARD ELECTRIC TIME COMPANY
Springfield 2, Massachusetts

SINCE 1884

THE STANDARD PRECISION TIMER
is the indispensable STOP Watch in laboratory and test cell, on experimental nuclear projects, precision production, check and final inspection. Many important applications in almost every industrial plant and research laboratory.

For more information circle **13** on inquiry card.

Split Seconds

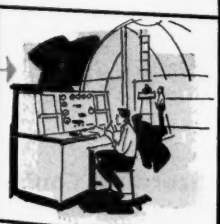
ELAPSED TIME . . . AS CLOSE AS 0.001 OF A SECOND

PRACTICALLY ALL Representative Manufacturing, Processing and Research Plants *USE* STANDARD PRECISION TIMERS

At one of the world's largest automotive manufacturers — timing test action in automatic transmission research.

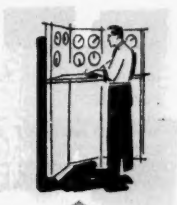
It is our frank belief that literally hundreds of concerns have not yet scratched the surface of usefulness to which Standard Precision Timers can be put to work in their plants.

For Glenn L. Martin Co.'s Gunnery Trainer — in 12-channel Playback System designed by Cook Research Laboratories.



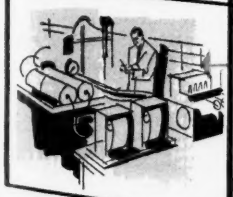
At Eastman Kodak Co. — timing photo cell controlled exposures in automatic photo printing machine.

At Yucca Pass, Nevada Proving Grounds — helping maintain split-second control of atomic bomb tests.

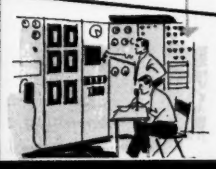


At General Electric Co. — Trumbull Division — measuring operating time of circuit breakers.

In Bell Telephone offices throughout the U. S. — timing elements required to complete telephone connections.



At Bendix — Westinghouse Research Dept. laboratories — measuring brake application and release time to 1/100th of a second.



At American Brass Co. — indicating metallurgical analysis in Direct Reading Spectroscope developed by Baird Associates.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1 5 sec.	6000 sec.	±.1 sec.
S-60	1 5 sec.	60 min.	±.1 sec.
SM-60	1 100 min.	60 min.	±.002 min.
S-10	1 10 sec.	1000 sec.	±.02 sec.
S-6	1 1000 min.	10 min.	±.0002 min.
S-1	1 100 sec.	60 sec.	±.01 sec.
MST	1 1000 sec.	360 sec.	±.001 sec.
MST-500	1 1000 sec.	30 sec.	±.002 sec.

World's most accurate and rugged time measuring instrument. Built in many different and advanced designs to meet practically every need of precision time measurement. Requires minimum maintenance.

Synchronous motor drive. Electric clutch controlled by manual switch, automatic switch or output of electronic tubes. Manual or electric zero reset.

SEND TODAY for Bulletin #198 describing entire line with partial list of thousands of customers, and summary of some of the most frequent (and some of the most unusual) ways they use STANDARD ELECTRIC TIMERS.

The STANDARD ELECTRIC TIME Co.
93 Logan St., Springfield 2, Mass.

Please send Bulletin 198 describing your line of instruments for measuring elapsed time as close as 0.001 seconds.

Name.....Title.....

Firm.....

Address.....

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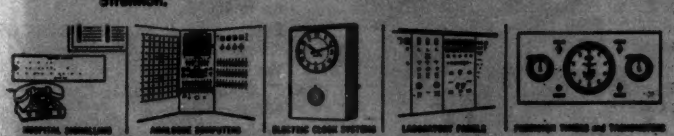
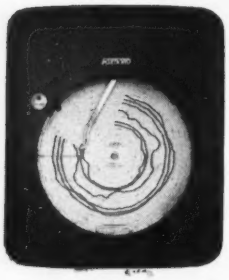
We suggest you check your requirements for Standard Timers and other products today. Your order or inquiry will receive prompt attention.



For more information circle **13** on inquiry card.

GET THE BEST SOLUTIO
TO ANY TEMPERATUR P
with Foxbor In

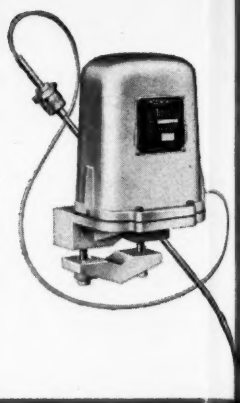


Dynalog Electronic Instruments

Complete line of indicators, recorders, and controllers employing the advanced Dynalog measuring system in which a friction-free air capacitor replaces conventional slide-wire — provides continuous, stepless balancing action. Dynalog Instruments provide up to six records on a single round chart. For use with resistance or voltage type primary elements — pneumatic or electric control action.

Multi-Record Dynalog

- 6 color-coded temperature records on one round chart.
- Each record line a distinctive, non-smudging color.
- No slidewire — no batteries — no standardizing.
- Thermocouple or resistance bulb types.



Mod Pneu

- Simp pera rang 200°
- Com ture
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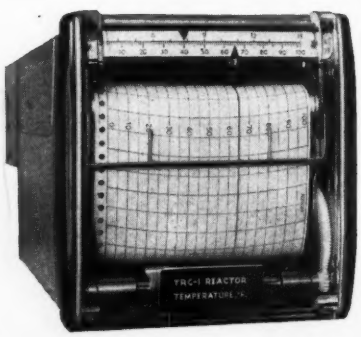
- Suit or o



Consotrol Recording Control Station

One of the complete Consotrol line of compact panel indicators, recorders, and controllers. This advanced control station features full (" chart and scales, six-months' ink supply, bumpless auto.-man. transfer. The M/58 Consotrol Controller, shown here integrally mounted, provides

- All four control actions, with two reset ranges, easily adjustable to widest variations in operating conditions.
- Easy lever-setting proportional band, calibrated to 500%.
- High sensitivity and precision due to unique "floating disc" balancing action — even at widest settings of proportional band.
- Interchangeable "plug-in" components.
- Continuously variable reset resistance gives 500:1 rangeability.

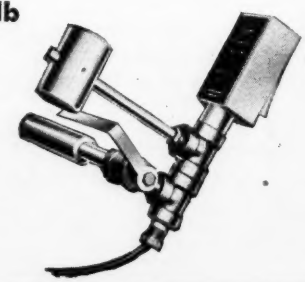
PRIMARY ELEMENTS

A complete selection of primary elements for filled thermal systems, resistance bulbs, and thermocouples. Besides standard and thermocouple types, special elements and accessories are available to meet the requirements of virtually any industrial application.

Dynatherm Resistance Bulb

For use with Dynalog Electronic Instruments.

- Superior measurement performance for temperature up to 600°F.
- Fastest response due to positive metal-to-metal end contact with standard wells or sockets.
- Highest sustained accuracy. Permits use of extra-narrow scales — ideal for precise temperature difference measurements.



Roll Surface Temperature Element

- Continuous, automatic measurement or control of roll surface temperatures up to 450°F.
- Extra-rugged construction — with a "feather" touch. Won't mark or score the roll.
- Eliminates friction, radiation, and convection errors.
- Simplest, most accurate way to measure roll surface temperatures.

PROBLEM | from −450°F to +2800°F

Instrumentation

Model 12A Temperature Pneumatic Transmitter

- Simple way to measure remote temperatures in the −100°F to +1000°F range. Operating spans of 50°, 100°, 200°, and 400°F.
- Compensated for ambient temperatures and pressures.
- Compact, easily installed. Uses regular ¼" O.D. tubing transmission lines — no troublesome conduits, no costly capillary tubing.
- Suitable for any hazardous, corrosive, or outdoor location.

Electric Proportional Action Controller

- Can be used with any Foxboro measuring system — mechanical or electrical.
- Precise, frictionless control action through electronic relay and electric valve operator.
- 3 types of proportional control action available.
- Setting knob permits easy, stepless adjustment of control band throughout range of instrument.

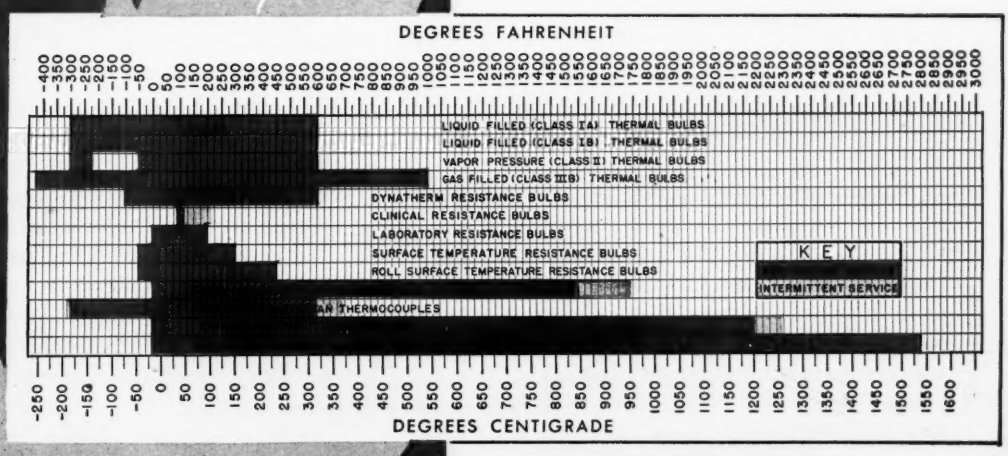
Whenever you have a temperature problem in the −450°F to +2800°F range, you can depend on Foxboro Instrumentation for the best solution. Foxboro's outstanding combination of truly advanced instruments and unequaled experience in applying them, has successfully solved temperature problems as widely different as helium liquefaction and jet engine testing. Foxboro offers a wide variety of primary elements, transmission devices, indicators, recorders, and controllers. Whether a single instrument or a combination is required — filled-system, electronic, or electric — you can be sure of fitting the process *exactly*. Unique Foxboro developments, such as Dynalog* Electronic Instruments, Dynatherm** Resistance Bulbs, and the 12A Temperature Transmitter, continually maintain control standards in step with every advance of modern processing. A few of the instruments which typify Foxboro's better-engineering are shown on these pages. Chart below shows complete temperature ranges covered by Foxboro measuring systems. Write for complete details. **The Foxboro Company, 4610 Norfolk St., Foxboro, Mass.**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

FOXBORO
Reg. U.S. Pat. Off.

TEMPERATURE
measurement and control

Locate your problem temperature in this table



*Reg. U.S. Pat. Off. **Trademark

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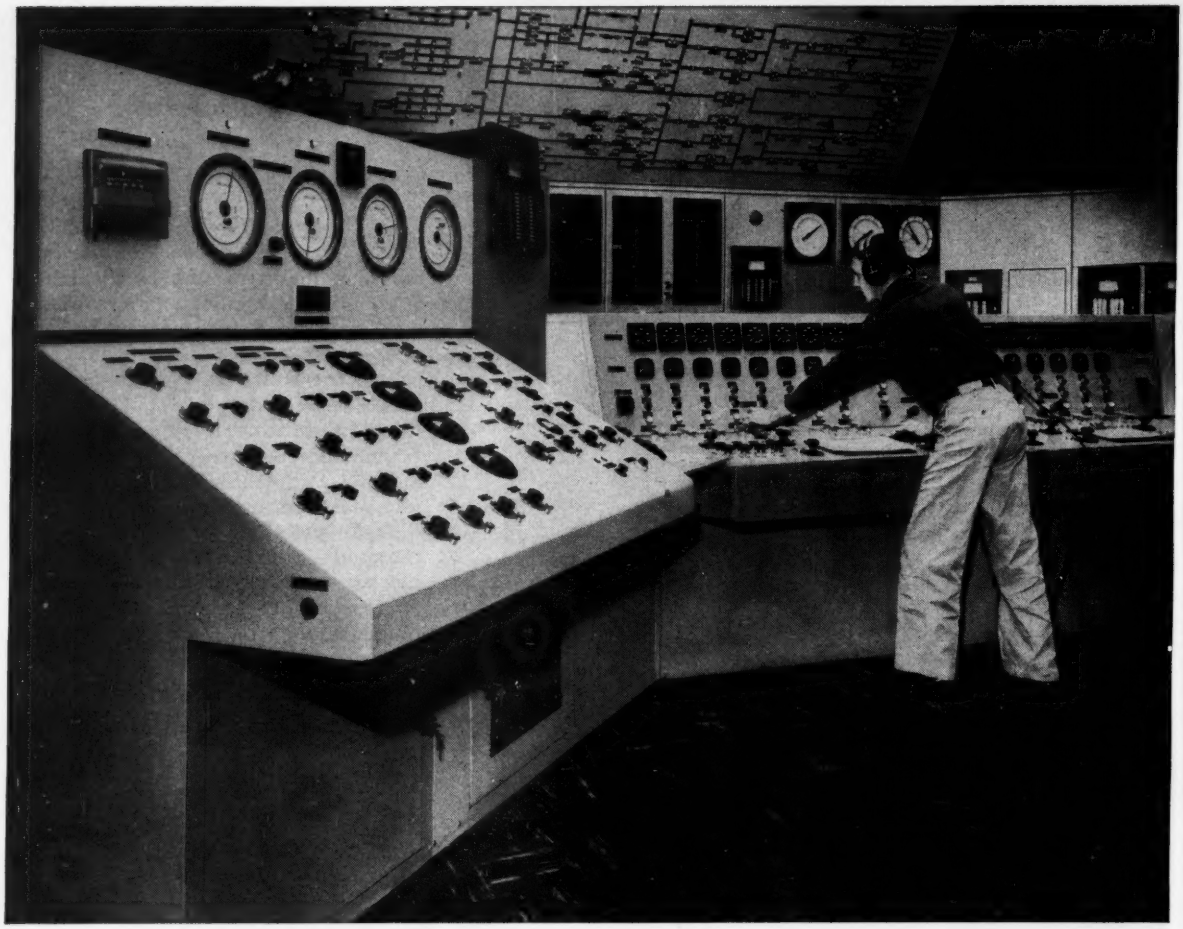


Hagan tames the whirlwind

Hagan automatic altitude control tames a veritable whirlwind at the Arnold Engineering Development Center's Engine Test Facility. The giant Tullahoma, Tennessee testing center, one of the key installations of the U. S. Air Force's Research and Development Command, uses Hagan systems to accurately simulate flight conditions up to 80,000 feet within engine test cells.

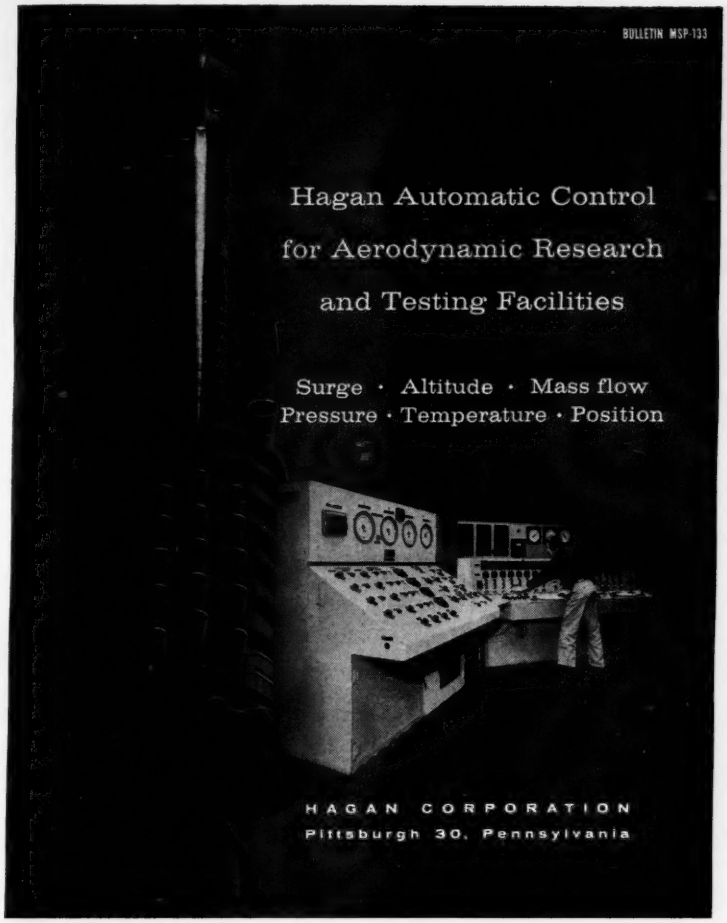
The altitude control is only one of seven major types of Hagan automatic systems, many of which will be used on all three of the A.E.D.C. facilities. The Hagan high performance devices used in these systems are available as separate components or may be integrated into automatic controls for such services as:

Surge Control • Altitude Control • Density Control • Pressure Control • Electro-Hydraulic Valve Positioning • Electro-Pneumatic Valve Positioning • Safety Interlock Systems

Hagan Corporation has been producing control systems for aerodynamic test facilities since 1939. Hagan control and instrumentation systems and components are in service at many of the major test facilities in this country. The development of high speed, high precision devices and electro-hydraulic pilot valves capable of controlling up to 300 fluid hp. have been pioneered by Hagan.

Hagan is prepared to furnish control system components for aerodynamic testing facilities or other process control functions.

For more information circle **15** on inquiry card.



NOW AVAILABLE!

NEW CATALOG LISTS HAGAN HIGH SPEED, HIGH POWER COMPONENTS FOR AERODYNAMIC TEST FACILITIES

These Hagan devices provide the research engineer with new tools to facilitate test procedures. Hagan PowrAmp components are extremely accurate and dependable, and include transducers, controllers, computers, amplifiers and high capacity pilot valves. These components are suitable for the instrumentation and control of such factors as:

Surge • Altitude • Mass Flow

Pressure • Temperature • Position

at A.E.D.C.

Bulletin describes General Characteristics of Hagan PowrAmp Components

Hagan Bulletin MSP-133 contains specifications, applications, accuracy classifications, frequencies, and inputs and outputs of twenty-two different units. The units described include transducers, amplifiers, converters, controllers and a variety of other devices such as signal shapers, signal generators, power supplies, control stations and others.

Copies of this catalog available on request—ask for Bulletin MSP-133.

HAGAN CORPORATION
HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

Systems and Components for: Aeronautical Testing Facilities, Process Control, Boiler Combustion Control, Metallurgical Furnace Control • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.

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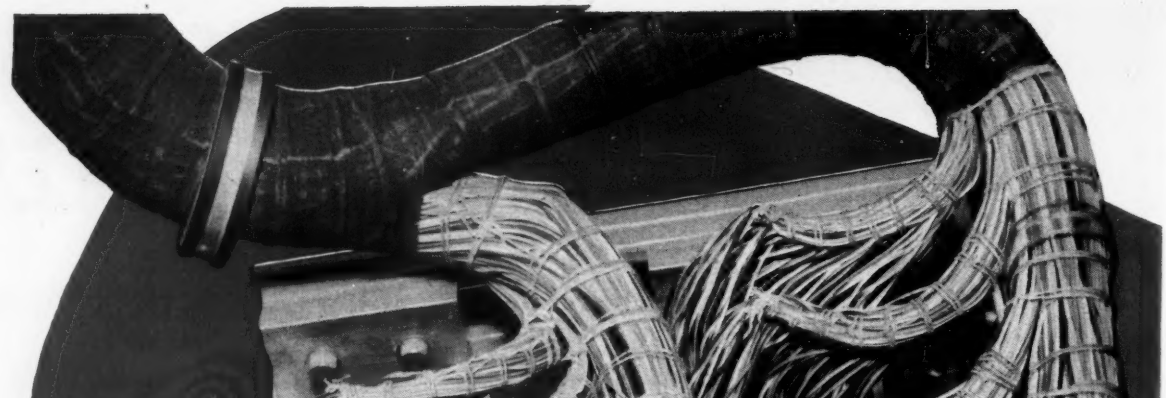


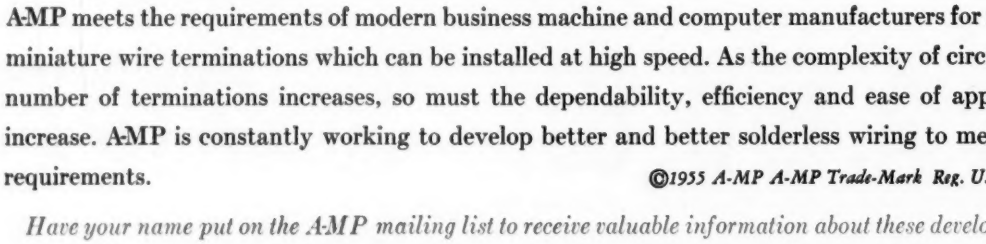
Here's One Reason Why You Should Know About A-MP Terminals

A-MP meets the requirements of modern business machine and computer manufacturers for reliable, miniature wire terminations which can be installed at high speed. As the complexity of circuits and number of terminations increases, so must the dependability, efficiency and ease of application increase. A-MP is constantly working to develop better and better solderless wiring to meet these requirements.

©1955 A-MP A-MP Trade-Mark Reg. U.S. Pat. Off.

Have your name put on the A-MP mailing list to receive valuable information about these developments.

Examples of the advanced thinking that is part of all AMP solderless wiring devices:



A-MP TAPER PINS (1) and TAPER TAB RECEPTACLES(2) designed to save space and weight in electronic circuitry. A-MP Pre-Insulated Diamond Grip Terminals (3) eliminate tape and spaghetti and are used extensively by every major aircraft producer. A-MPLIVAR Splices (4) speed production for mass produced motor windings, transformers, etc., using enamel, poly-vinyl acetal or similarly coated wire. A-MP FASTON Terminals (5) for all kinds of electrical appliances have revolutionized harness sub-assembly methods.

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The Big Hot Wind in the Open Hearth

Panhandle Pete

I read in the March issue of this magazine where Mr. J. J. Pollard of Manning, Maxwell and Moore, Inc. is suspicious of our Uncle Milton's motives and also believes that there is "little of moral or cultural value, strictly speaking, within the contents of your publication." Hmmmmmm! I am tempted to agree with Mr. Pollard for, in the words of Oscar Wilde —The old believe everything, the middle-aged suspect everything, the young know everything. Besides, who ever reads so many favorable "letters to the editor" as you do in this magazine?

As to the other complaint I can only say that Milton is trying to edit the most up-to-date authoritative magazine in the field of instrumentation (Can't you D.R.'s picture the big vacuous smile on M.H.A.'s face as he reads this?) and if you have read these columns of mine you will understand, loosely speaking, where the cultural value of the magazine lies. Why certainly there are cultural items! When Milton and I were at Carnegie Tech a cultural subject was one which we didn't think had much to do with engineering—english, history, etc. What other writer (writer? —Ed) for *Instruments and Automation* strays so far from the field of instruments as Panhandle Pete? A good "ferinstance" was the description, by the Editor of the *Simulation Council Newsletter* for April, of how he used to whistle for wind on Lake Pontchartrain. When I was younger and sailed boats on the Ohio River, we would sometimes find ourselves faced with a long row home so we whistled and threw water on the sails. (Now that all you D.R.'s know how to make the wind blow I do not want to see any more of this culture in this magazine. Ed.) As another "fer instance" I have written up a discussion of instrumentation for open-hearth furnaces that someone told me about over a strong cup of coffee. Culturally, I think this is a dilly! It goes something like this:

A. Why do we pay a first helper some fifty dollars* for an eight hour day? Is it for opening and closing some valves and pushing a button every ten or fifteen minutes? Is it for opening and closing furnace doors every once in awhile? Or is it to make changes on various controls which no one knows too much about? No, I don't think so; we could teach common labor to do these jobs.

B. What kind of people are these first helpers? Well these people range from *excellent* to *poor* in any classification you care to name. Since there is no formal education program in the mill for these people it seems to me the future first helpers will be about the same as the present one.

C. What kind of control systems are we apt to install in the future for controlling a furnace? The present trend is towards more and more instrumentation until we surpass the glorious confusions installed in the past.

D. What do we do with all this control? The daily charts? Or anything else pertaining to the control so long as it operates? Generally speaking, no one looks at the charts except the meter department (sometimes I wonder if we do not furnish all these recorders just to help keep our own men busy). It is also common knowledge** that there are a great number of furnace settings which are not changed, and some settings which should be changed but are not, and still others which are set wrong.

E. What are the answers to these four questions? With regards to "A" I feel that these questions can be answered by saying that all these jobs are by-product functions which we derive from our fifty dollar a day man. His main job is to make steel! "B" I see no way to answer or solve the problems brought up by these people as per se. These people are a good example of homo sap in all his glory—forgetful, easy going, hard-working and so forth, but for fifty bucks a day you'd like to have a combination metallurgist, combustion engineer, instrument man and crystal-ball gazer, wouldn't you, hmmmm? Since there are few individuals as just described this brings us back to homo sap again. I expect to discuss "C" a little later on. And "D" brings up a subject so involved with the other three questions that I have but one answer and it isn't too good: employ a crew of men to operate the furnaces. This would immediately increase labor cost and invite friction with the present personnel.

F. So what do we do about this problem? First of all we have to assume the first helper knows how to make steel*** and since we have also assumed we are paying him this fifty dollars for making steel we should give this man tools to allow him to make all the steel he can. We do this by eliminating operating errors and confusion and end with a new type control system consisting of (1) a large gauge and (2) a selector switch. The gauge will have a red-colored dial with a small green sector in the center. The selector switch will have positions marked 'Melt Down', 'Work Lime' and so forth as needed. Thus if the first helper knows what his heat is doing or what he wants it to be doing, any given setting on the selector switch will pre-set all the furnace functions to optimum setting and the large gauge will read "in the green" if all the functions are as called for.

G. What will we accomplish with this one knob and gauge control system? Obviously this control will have the advantage of utter simplicity from the operations angle. We will

* Insert your own pay scale for first helpers.

** I have listened to and read many reports from open hearth committee meetings and have come to the conclusion that operators are unhappy with present controls, first helpers, maintenance of control and metermen in general.

*** This is a delicate subject.

Continued on page 1914

VICTOREEN OFFERS A MEANS TO SAFETY FOR EVERYONE EXPOSED TO RADIATION

The ever increasing use of atomic and nuclear energy in manufacturing and processing industries requires ultimate safety measures for the protection of *all persons,* even those casually exposed to radiation. Radio active products affect not only people involved in production processes but in all handling services such as receiving, shipping and transportation. And it is these marginal contacts that can be most severely affected by radiation, for which Victoreen Personal Dosimeters offer a complete measurement of safety.

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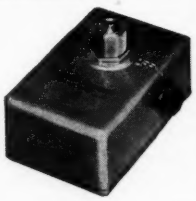
Victoreen Pocket Dosimeters are about the size of a pen and clip into the pocket. After being charged on the 561A Dosimeter Charger, to zero position, radiation exposure causes leakage which is reflected on a direct reading scale built into the pocket dosimeter. User need only hold Pocket Dosimeter toward a bright light —look into tube and read the accumulated roentgen dose.



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When a group of people must be safeguarded against radiation over periods of time, the indirect reading personal dosimeter instrumentation has several advantages. Daily x-ray exposure methods can be maintained, establishing medical and legal evidence of daily exposure and improved personnel relations are acquired as a result of more than adequate health-safety measures.

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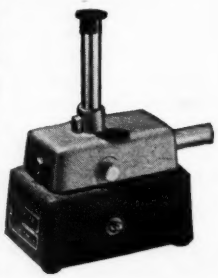

STRAY RADIATION CHAMBERS

Available for use with the Minometer are stray radiation chambers for detecting and measuring x-ray or gamma radiations in any area suspected of being subject to the hazards of stray radiation. Chambers are quickly charged and exposure accurately measured on the Minometer.

Illustrated catalog, giving detailed specifications of all Victoreen Dosimeter instruments available on request. Ask for Bulletin 3042.

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Victoreen manufactures a variety of special instruments for measuring the radiation level in hazardous locations and initiating alarms and/or interlocks if the level is either higher or lower than a pre-set intensity. This includes radiation proof alarms for very high intensity sources as well as low level personnel monitoring. We welcome inquiries for special multi-station monitoring devices designed to your requirements.

INSTRUMENTS DIVISION

The Victoreen Instrument Co.

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PANHANDLE PETE—CONT.

have the benefit of optimum furnace settings for any given operation. Our first helper can make steel without worrying about these little chores we bother him with now*. It is no longer necessary to have a high-priced panel located on higher priced real estate.

H. Who selects the pre-set settings for the furnace functions**? This is easy to answer. In the language of the open hearth, "Who raises hell with the first helpers when they aren't running the furnaces right" at the present time? Usually this hell-raiser is the superintendent or one of his deck-hands. In some of the more enlightened shops there is an individual of genus engineerus combustiblus and he throws a lot of, er, weight. In any event if you do not allow this hell-raiser to make the settings, you might as well go home because he'll never be satisfied—even if you are right.

I. How does one know what settings are best? Don't be ridiculous! How long have you been reading this magazine? (I was going to be naive and say that experience is the best teacher for control setting, but this is 1956 and the age of the computer.) Every reader of *I&A* now knows all about analog computers and how you just push a few buttons, twist a few (hundred) knobs, plot a few curves and come up with the "optimum."

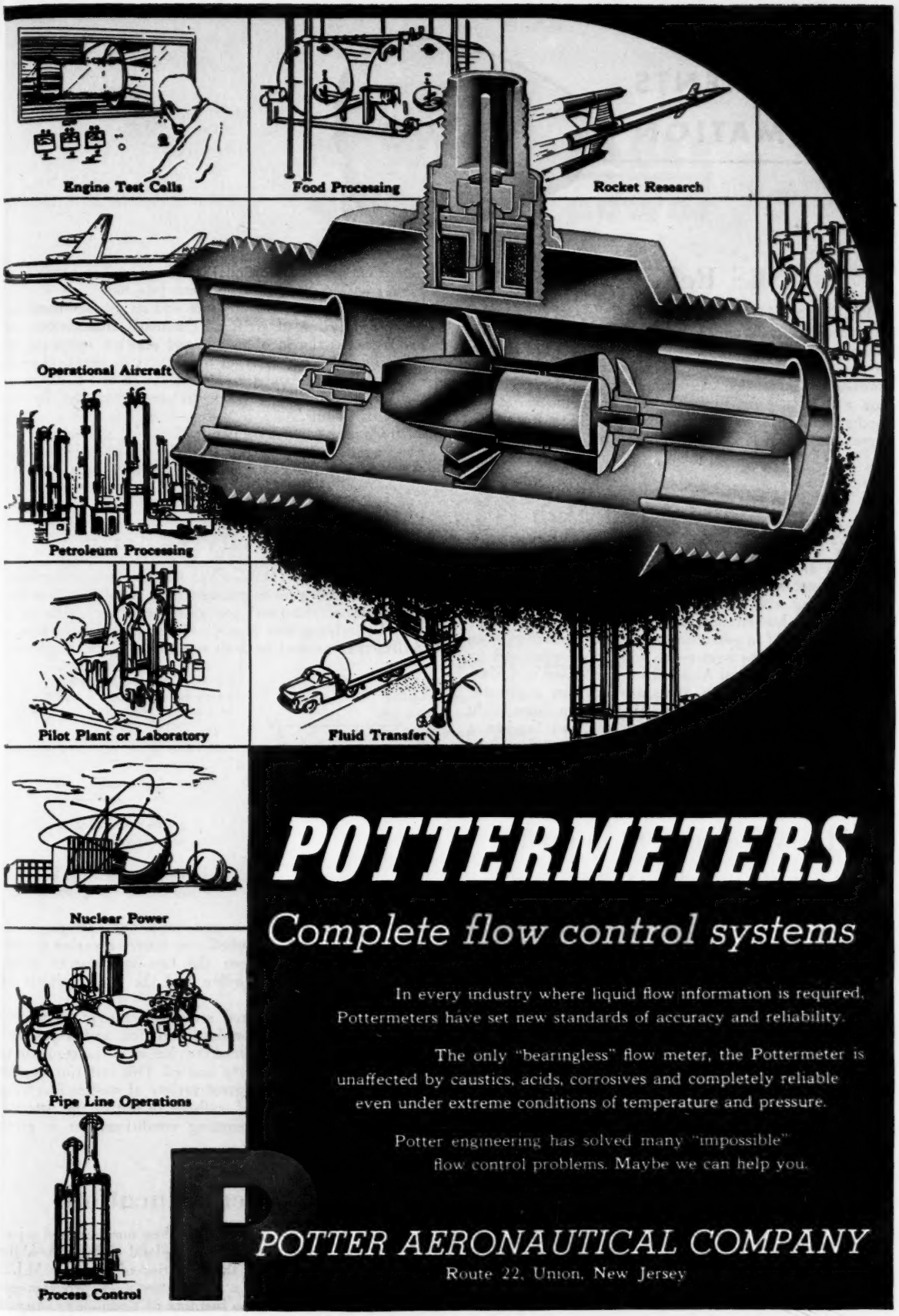
J. Cost? If we do away with all the recorders and used indicators instead, and placed these control panels out of the way instead of where we do, and make them look less like show cases, we might just save enough money to pay for a one-knob-and-gauge control. Otherwise the cost of this simplified control might run about 10.2% in addition to the original cost of the control. But if we add the cost of the computer with which we are going to find out how to determine the optimum settings of the furnace controls, the amount involved—compared with the tremendous improvement in production and furnace life is a piddling amount—just ask any computer salesman!

---

*A few of the first helpers do worry once in awhile.

**These functions are those which you operators growl about not being watched. It is obvious that there is some combination of settings which is best for any furnace which will yield the most tonnage with best furnace life over a period of time.

Panhandle Pete



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INSTRUMENTS and AUTOMATION News

NBS Relocation

WASHINGTON, D.C.—The National Bureau of Standards will relocate to 550 acres of land near Gaithersburg, Maryland. The new site will enable the Bureau to plan for a more up-to-date plant consistent with its continually increasing responsibilities. The rural location will remove the Bureau's work from the variety of mechanical, electrical, and atmospheric disturbances present in a city.

Automation and Man

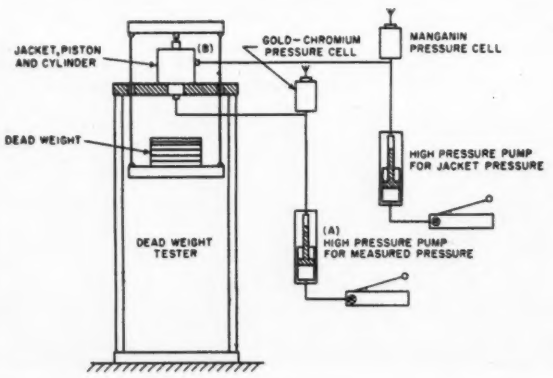
NEW YORK, N. Y.—The "Human Engineering—Automation and Man" conference to be held in the New Yorker Hotel during Automation Week (Nov. 26-30) will be concerned with the design of machines, systems, and products for human operation and use. Specific attention will be paid to personnel and to the consumer in an automated age. The conference will be co-sponsored by the Third International Automation Exposition and Manhatten College, with Dr. Douglas Courtney moderator for the eight sessions. Registration fee includes eight conference sessions, four clinic sessions, two lunches, a banquet, transcriptions of the discussions and papers, and review of show exhibits.

High-Pressure Standards

WASHINGTON, D. C.—National Bureau of Standards has undertaken development of instruments and standards that will permit more accurate measurement of pressures up to 200,000 psi. Partial support is provided by Watertown Arsenal of the Army Ordnance Corps and the Interior Ballistics Laboratory at Aberdeen Proving Ground. Up to the present, nearly all measurements in this field have been referred to fixed pressure points, and determination of additional fixed points is needed as higher and higher pressures come into use.

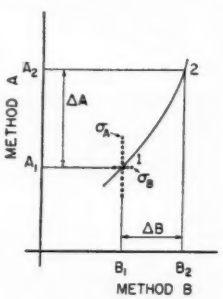
Applications of high pressure and its measurement include production of artificial diamonds, manufacture of ordnance, extrusion of metals and plastics, operation of oil wells, a wide variety of operations in chemical technology (such as catalytic polymerization and hydrogenation), and study of the high pressures generated by nuclear explosions.

Illustration shows the calibration of a gold-chromium gage against the NBS controlled-clearance piston gage (dead-weight tester) in measuring the melting pressure of mercury at 0°C (about 110,000 psi).



Sensitivity Criteria

WASHINGTON, D. C.—National Bureau of Standards has introduced a more generalized form of the "sensitivity conceptor criterion" for instruments and methods of test. Underlying this concept is the requirement that a satisfactory method be both reproducible and responsive to changes in the objects measured. For example, comparison of two paper smoothness testers revealed a complex relationship between the two instruments which might have been misleading had the usual criteria of merit been used.



The ratio of sensitivities of methods A and B for measurement of a very small increment of property Q is: $\frac{\Delta A}{\sigma_A} / \frac{\Delta B}{\sigma_B}$.

Since $\frac{\Delta B}{\sigma_B}\left(\frac{\Delta B}{\sigma_B}\right)$ is greater than $\frac{\Delta A}{\sigma_A}\left(\frac{\Delta A}{\sigma_A}\right)$,

B is the better method although A is more responsive.

COMPARISON OF TWO METHODS FOR THE MEASUREMENT OF A PROPERTY Q

In the new generalized senitivity concept, *reproducibility* is measured by standard deviation, and *responsiveness* is measured by ratio of the change in the response to the change in the property studied. This criterion can be used to advantage in a great variety of studies involving either the comparison of methods of test or the determination of optimum operating conditions for a given method.

Computer Education

CAMBRIDGE, MASS.—More than one hundred scientists and engineers from New England colleges took the first step toward using the facilities of the new M.I.T. Computation Center at a special two-week program opened at the Massachusetts Institute of Technology, August

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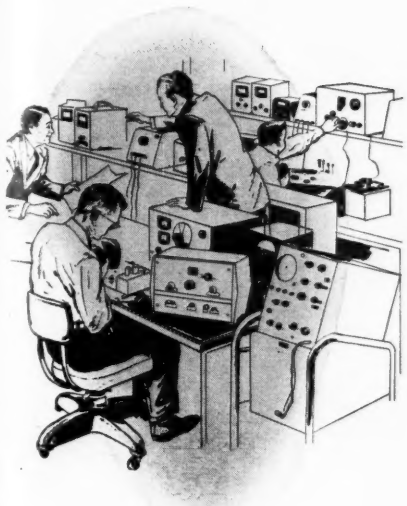
400 cycle power



This new frequency changer makes it possible to provide well regulated 400 cycle power conveniently and quickly. This unit, Model FCR 250, is extremely useful in a wide variety of applications including testing, production, airborne frequency control, computers, missile guidance system testing, and in practically any application where the use of 400 cycle power is advantageous.

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Frequency regulation	**±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)**
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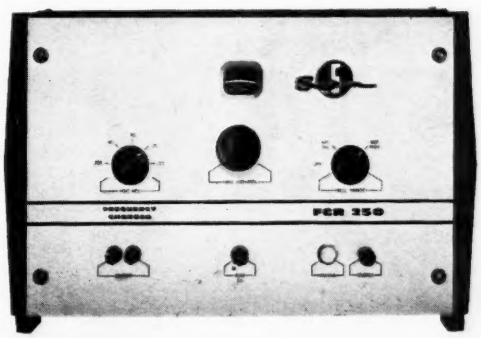

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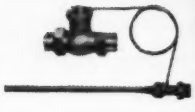

Nos. 928-D1, E1, F1 & G1 TEMPERATURE REGULATORS—control of liquid temperature in food processes, etc.

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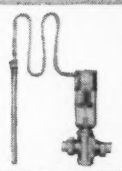
No. 923-Q TEMPERATURE REGULATOR—quick adjusting type for process control, etc.



No. 926 TEMPERATURE REGULATOR—safety type for engines, process control, etc.

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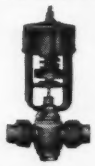

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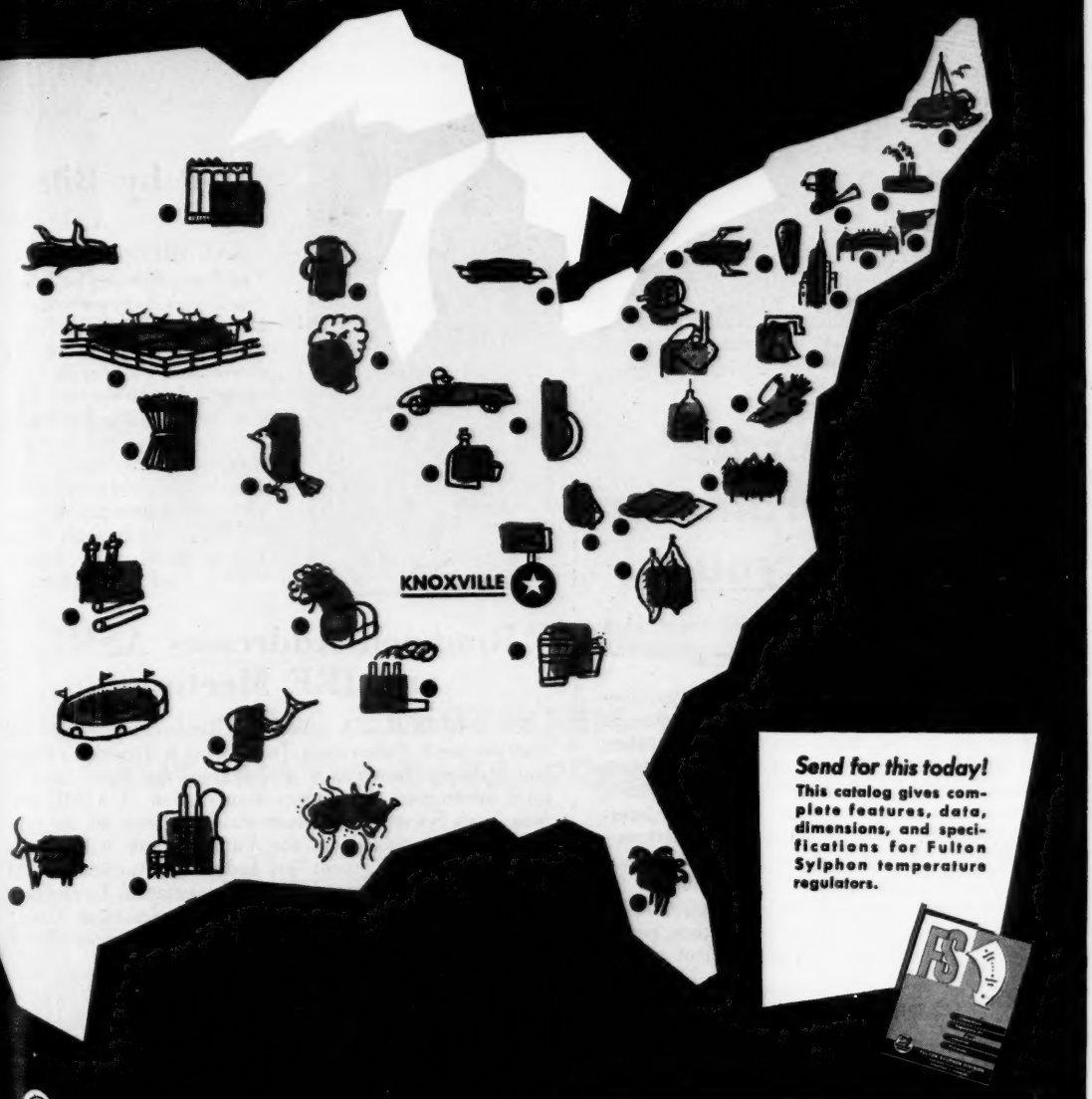

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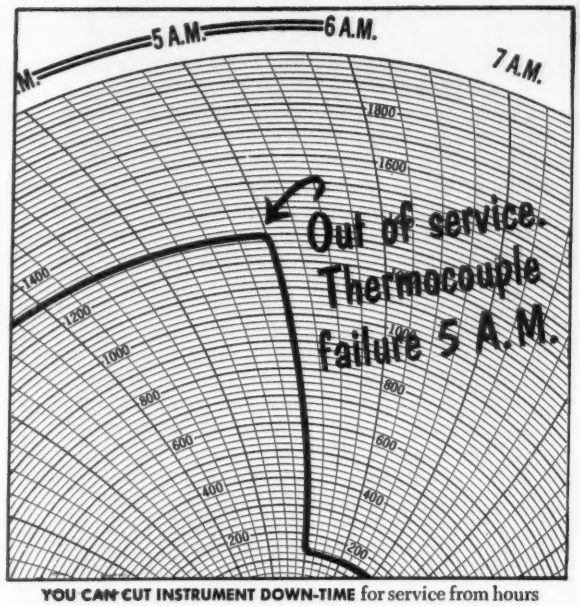

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AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

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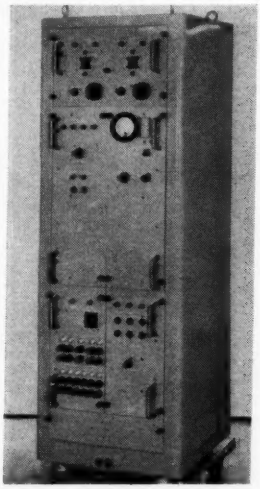
NEWS —CONTINUED

20. The program, marking the opening of a cooperative venture between the International Business Machines Corporation, M.I.T., and at least 23 other New England colleges, is designed to increase the number of scientists and engineers qualified to use computing machines by teaching the principles of preparing problems for computation. Under special arrangements with I.B.M., a type 704 computer will be installed early next year, for operation at the M.I.T. center.



R-θ by Bits

SAN DIEGO, CALIF.—The Navy Electronics Lab., San Diego, has received delivery of Electronic Engineering Co. equipment for conversion of bearing and range information into digital form suitable for transmission over radio voice communication links. The unit has two channels, each of which represents the positions of each shaft of a two-speed synchro system with a 12-digit number.

Rimbach Addresses ASME and IRE Meetings

PITTSBURGH, PA.—Richard Rimbach, publisher of *Instruments & Automation*, *Instrument & Apparatus News* and *Military Automation* will address the November 15 joint meeting of the metropolitan section of ASME and New York Society of Professional Engineers on the subject of "Automation in the Future," and will act as Chairman of the session on Industrial Applications of Instrumentation at the IRE Instrumentation Conference & Exhibit, sponsored by the IRE Professional Group on Instrumentation, Dec. 5-7, Atlanta, Biltmore Hotel.

Digital Reports

WASHINGTON, D.C.—The Office of Technical Services, U.S. Department of Commerce, has released the following reports: (1) "An Experiment in Universal Coding," S. Gorn, Ballistic Research Laboratories, U.S. Army. Aug. 1955. 83 p. $2.25: Order PB121055 from OTS, U. S. Department of Commerce, Washington 25. (2) "High-Speed Reader for Perforated Tape," R. J. Bianco, Ballistic Research Labs., U. S. Army. Sept. 1955. 17 p. $.50: Order PB121057 from OTS. (3) "A High-Speed Shift Register," S. R. Ray, Ballistic Research Labs., U. S. Army. Sept. 1955. 14 p. $.50: Order PB121060 from OTS. (4) "Medium-Speed Digital Plotter," P. M. Kintner and E. A. White, Ballistic Research Labs., Oct. 1955. 35 p. $1: Order PB121056 from OTS. (5) "Sonar Digital Recorder—Digiter," A. G. Pieper and R. Q. Tillman, Naval Research Lab. June 1956. 10 p. $.50: Order PB121220 from OTS.

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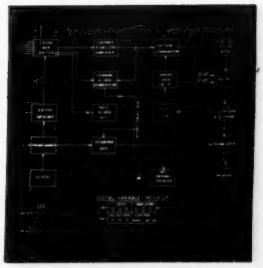

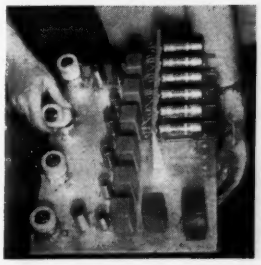

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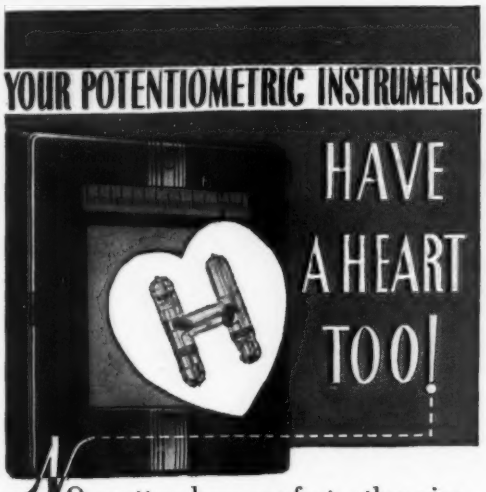


NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
As Standard as Sterling

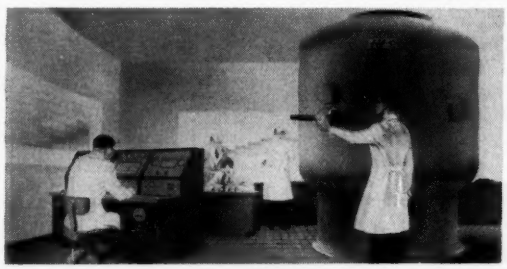
For more information circle **23** on inquiry card.

Automatic Tube Testing

COLLEGE POINT, N. Y.—New "DynaMatic" tube tester by TeleTest Instrument Corp. uses perforated cards to automatically set up pin connections and test voltages to tube sockets on the test panel. Setting heater voltage and a 'calibration' control are the only manual operations required in set-up. Inserting the punch-coded tube-type card automatically turns the tester on; withdrawing the card turns it off. The coded contacts are made by plated steel balls pressed against contact strips by phosphor-bronze coil springs.

Mass-Produced Reactors

SAN RAMON, CALIF.—Aerojet-General Nucleonics announces it is beginning the world's first mass-production of small portable self-contained nuclear reactors. Using



a method of core fabrication with radiation-stabilized polyethylene moderator, the reactor resembles a liquid homogeneous reactor but actually has a solid homogenous core. The requirement for critical mass is approximately 600 grams of Uranium 235 of 20% enrichment, said to be less than any known reactor.

Transistor News

PHILADELPHIA, PA.—Philco Corp. announces a new technique for the mass production of UHF transistors. New MAT and SBDT devices are fabricated from the element germanium and utilize surface barrier technique; the SBDT will operate at 500 Mc.

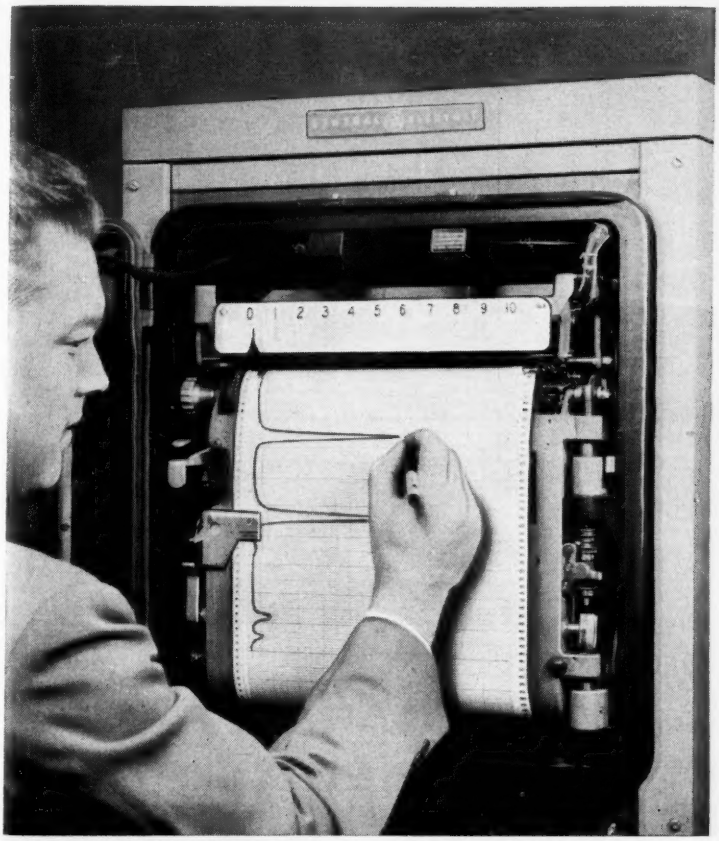
Missile Simulation

VAN NUYS, CALIF.—A UNIVAC Scientific 1103A of Remington-Rand, which will solve some problems involved in intercontinental ballistic missiles, will soon be put into operation by Lockheed's Missile Systems division. The machine is said to be the only machine in the world versatile enough to interrupt one complex problem to solve a new, high priority problem, while retaining all work on the first in its "mind" for subsequent solution.

NSF Colloquia

WASHINGTON, D.C.—National Science Foundation has released the following schedule for the 1956-57 NSF Colloquia Series. All meetings will be held in the board room of the Foundation, 1520 H. St., N.W., Washington,

"Our lab is seeking work we used to turn away...



...we cut our analysis time to one-fifth with our NEW G-E XRD-5 X-Ray Emission Spectrometer"

THE above statement from a large steel foundry reflects the contribution of this versatile General Electric apparatus to analysis programs in chemical, rubber and petroleum plants, as well as in metallurgy.

G.E.'s new X-Ray Emission Spectrometer has proved far faster and more precise than wet methods for quantitative analysis of elements down to atomic number 12 (magnesium). And because the technic is non-destructive, re-runs can be made immediately without preparing another sample.

Whatever your analysis requirements — research, raw materials or quality control — this General Electric diffraction unit can be adapted to your exact needs. Our x-ray representative near you will be glad to recommend the facilities best suited to your work load. Or write to X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin, for Pub. BL-104.

HELIUM ATMOSPHERE and a flowing gas proportional counter help detect small atomic number elements.

XRD-5S SPECTROMETER may be used exclusively for chemical analysis or quickly rearranged as a diffractometer for crystal analysis.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **24** on inquiry card.

better process management starts with

this

BOARD OF DIRECTORS

Whether you're responsible for managing a company or controlling a process, the Beckman "112" Data System – with exclusive PINBOARD PROGRAMMER – will help you do a better job.

How? By bringing you a *greater quantity* of *more accurate* operating data–in *useful* form–*immediately, instead of in days or weeks!*

Simply pin your instructions on the Pinboard, which, in turn, automatically directs the system to monitor the desired number of variables; record data on log sheets, cards, or tape; calculate material balances and product yields, and perform other functions. You are given a continuous picture of your plant operation–a chance to correct off-normal conditions and inefficiencies quickly, increasing product yield and quality.

"Magnetic core logic" – "floating" – semiconductor circuitry. Although these features in the "112" are of primary interest to the technical man, to the top executive they mean round-the-clock, round-the-calendar accuracy and reliability–data you can depend on, all the time. For complete information, write Beckman Instruments, Inc., Data and Control Systems Dept., Fullerton, Calif. Ask for Data File *D*-2-47

Our continued growth creates openings for creative engineers. Write for Career File No. 10.

Beckman "112" Data System, with exclusive "Pinboard Programmer".

See our Booth at the Automation Show

Beckman® / *scientific instruments*

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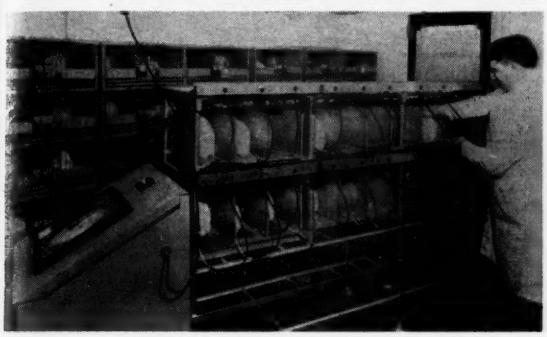
D.C. *High Energy Physics in the USSR* (Sept. 5); *Scholarship Problems and the Program of NMSC* (Oct. 3); *The Advancement of Science* (Nov. 7); *Genetics in Japan* (Dec. 5); *High School and College Mathematics* (Jan. 9, 1957); *Industrial Laboratory Research* (Feb. 6); *A Congressman Views Science* (March 6); *The Independent Research Lab.* (April 3); *New Horizons in Biological Research* (May 1); *Impact of Science Support on Higher Education* (June 5).

Pyrogen Testing

RENSSALEAR, N. Y.—Fielden Instrument Div. and Winthrop Laboratories have developed new electronic equipment for automatic and continual recording of body temperatures in testing for pyrogens. (fever-creating sub-



stances, derived from living things while free of living bacteria themselves). Measures to exclude pyrogens from intravenous preparations have been insituted by manufacturers of pharmaceuticals. The U.S. Pharmacopoeia sets forth exacting standards for testing as fatal results might occur in patients who need large amounts of intravenous fluids. Manual testing required one man full-time to test 30-35 rabbits in one day. New equipment improves test control by providing a continuous record of temperatures for 48 tests per day, with only part-time attention by technicians.

Grass Automation

DALLAS, TEXAS—Automatic grass-growing machines can provide forage for livestock the year-round. The "Herbagere" machine, invented by a Belgian, transforms grain into grass seven inches high in six days. Fifty pounds of pre-germinated seed can produce three hundred pounds of (man-made) grass daily. The critical temperature is automatically maintained by a special control unit developed by Minneapolis-Honeywell.

News Bits

TRANS WORLD AIRLINES will install the first *coast-to-coast* electronic reservations network to be used by any airline. A Teleregister "Magnetronic" system will keep track of the availability of all seats on TWA flights, domestic for 31 days and overseas up to six months in advance.

NUCLEAR DEVELOPMENT CORP. has been authorized to develop a sodium-deuterium reactor in part-

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for INDICATING, RECORDING & CONTROLLING TEMPERATURE, PRESSURE AND HUMIDITY
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Cat. 225A Glass Engraved Stem Thermometers and Hydrometers
Cat. 325A Dial Indicating and Recording Thermometers
Cat. 425A General Purpose Thermometers
Cat. 525A Dial Indicating & Recording Pressure Gauges
Dial Thermometer
Adjust-Angle Thermometers
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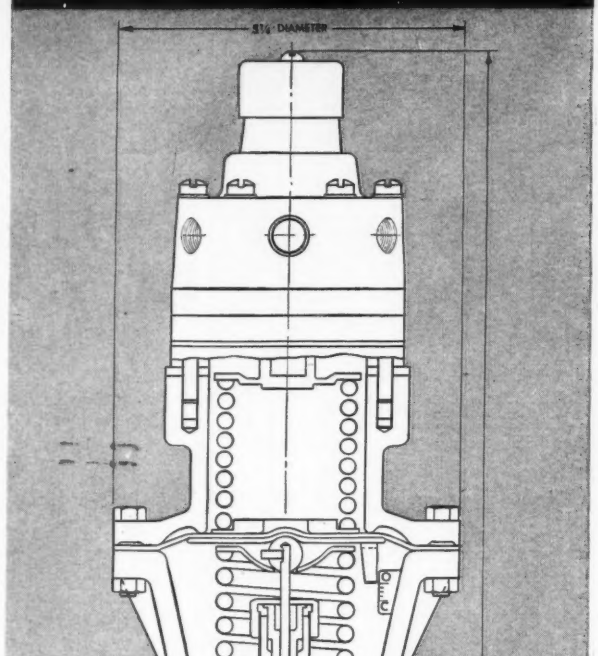
MINIATURIZED CONTROL



COMPACT • ACCURATE • RUGGED

Throttling 500 Series Bantam Diaphragm Control Valve with Top-mounted Moore Positioner.*

High Lift-Positioning Accuracy
Low Cost — Weight — Size

Valve Sizes — 1" Screwed or Flanged to ⅛" Screwed.
Trim Cv — 12.0 to 0.001.
Pressures — 0 to 2000 psi.
Temperatures — Minus 400 to Plus 1000° F.

*Other Positioners and Instruments Mountable on 500 Series Valves.

Write us for complete technical information, or the address of our representative in your area.

George W. DAHL Company
BRISTOL, RHODE ISLAND

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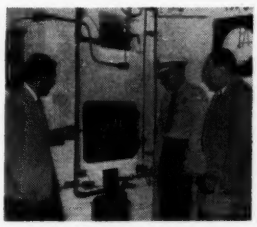
NEWS—CONTINUED

nership with the AEC and the Chugach Electric Assoc., Anchorage, Alaska. The proposal is for a power reactor of 10,000-kw capacity, using heavy water as moderator, liquid sodium as coolant, and slightly enriched uranium as fuel.

MINNEAPOLIS-HONEYWELL electronic relays control a new incinerator control system for use in the Department of Health Bldg. in Santa Ana, Calif.


M-H Electronic Relays

Berkeley Control

BERKELEY DIV., Beckman Instruments has introduced Statistical Quality Control to check out products at seven stages in the manufacturing process, beginning with inspection of parts received from outside suppliers. New method is said to cut possibility of defects in finished instruments by 50%.

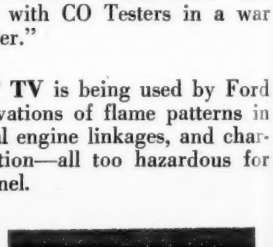
PLANET VENUS is the presumed source of Morse-code-like signals recently reported by Ohio State Univ. radio astronomer.

CHICAGO APPARATUS CO. now offers Service and Repair Policies, similar to the coverage purchased by many television set owners, to industrial users of *scientific instruments.* Periodic inspections, preventive maintenance, and emergency service are included.

MINE SAFETY APPLIANCES COMPANY has armed Cincinnati inspectors with CO Testers in a war declared on "The Silent Killer."

DAGE CLOSED-CIRCUIT TV is being used by Ford Motor Co. for remote observations of flame patterns in combustion chambers, critical engine linkages, and characteristics of engine lubrication—all too hazardous for direct observation by personnel.

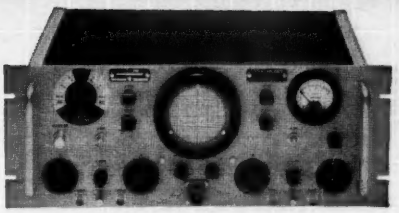
Dage Closed-Circuit TV


ALWAC

TWO PROCESS APPLICATIONS OF ALWAC computers are reported from the petroleum industry. One, installed at the Southwestern Computing Center, Tulsa, Oklahoma, solves complex oil and gas industry problems. The second, sold to Champlin Refining Co., Ft. Worth, Texas, will be used to compute the precise balance in blending crude oil, to realize maximum profit at minimum cost.

POCKETSCOPES® PULSESCOPES® RAKSCOPES® PANELSCOPES® RAYONIC TUBES®

SYSTEMS CONCEPT



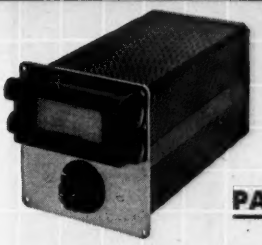
RAKSCOPE S-12-C

The Waterman SYSTEMS RAKSCOPE, S-12-C series is a rack mounted oscilloscope with SYSTEMS CONCEPT. Systems concept is a basic means for rapid monitoring of desired signals with minimum operative effort and without the use of auxiliary switching or jack panels. S-12-C series provide the following:

1. BASIC UNIT—The basic S-12-C SYSTEMS RAKSCOPE is a complete combination systems monitoring and trouble-shooting oscilloscope with outstanding physical and electrical characteristics. The RAKSCOPE occupies but 7 inches of a standard 19" rack and extends only 10 inches behind the front panel. Identical vertical and horizontal amplifiers are DC type having rise times better than 0.35 usec, and 50 or 71 millivolts rms per inch of deflection respectively. Signal calibration method uses a direct reading accurate meter. Time base sweeps are from ½ cps to 50KC in trigger or repetitive operation. Sync from internal or external sources provide stable operation by means of new sync lockout circuits. Special plug-in elliptical sweep circuit for easy phase and frequency checks greatly increase its systems utility. Construction is ruggedized throughout. Tube type options include standard commercial, ruggedized commercial or ruggedized military. Operable from 50 to 400 cycles.

2. CUSTOM MODIFICATION—Desired flexibility is obtained with the optional signal input selector. For the first time it is possible to select up to eleven different signal sources with the necessary built-in attenuation (supplied by us or by you) for each source. Thus the entire switching panel can be omitted from an overall system resulting in circuit and space economics. Standard elliptical sweep is 60 cycles, but plug-in units for other frequencies can be supplied. Accessories such as attenuating, direct, and amplifying probes are available.

Improve your existing or contemplated systems by including the S-12-C SYSTEMS RAKSCOPE as an integral part. Your local Waterman representative is ready to assist you in determining specific requirements.



PANELSCOPE®

The Waterman PANELSCOPE is a custom-built cathode ray tube oscilloscope, with simplified operation, and yet available at a low price. The PANELSCOPE concept provides for the following:

(1) MINIATURIZATION—Panel space required is only 5¼" x 5-3/16"—depth is 10" and the weight is less than 7 lbs. The PANELSCOPE can be installed in practically any equipment—mobile or stationary—air, sea, or land—military or commercial.

(2) SIMPLICITY OF OPERATION—Twist of a single rotary switch provides a synchronized pattern of desired incoming signal (up to 11 circuits) against proper linear time base. This is ideal for monitoring and trouble shooting, as it removes the need of fiddling with knobs as is done now on general purpose oscilloscopes. The static controls, such as beam, focus, positioning, and graticule brightness are located in tube escutcheon.

(3) CUSTOM DESIGN—A wide variety of—signal amplifiers with response from dc to megacycles and sensitivities from 5 millivolts—synchronized or triggered linear time base generators from ½ cycle (and lower if need be) to 2 microseconds—can be specified by you to fit your needs for particular equipment.

(4) PARTIAL KIT FORM—the PANELSCOPE comes fully wired and tested with chosen signal amplifier, linear time base generator and attendant sync. amplifier. The desired signal attenuators, frequency and amplitude determining components, and method of synchronization can be installed either by us or by you.

(5) POWER REQUIREMENT—Less than 10 watts of line power for built-in high voltage supply—The required B+ and heater current as selected by your requirements. For those cases where B+ and heater power is not available, auxiliary power pack can be supplied.

There is a place in your equipment for Waterman PANELSCOPE, a custom built oscilloscope at production prices, although your needs may be but one or two. Ask for specification sheets either from our representatives or direct from the factory.

RAYONIC CATHODE RAY TUBES BY WATERMAN

TUBE	PHYSICAL DATA		STATIC VOLTAGE		DEFLECTION*		LIGHT OUTPUT**
	FACE	LENGTH	A3	A2	VERT	HOR	
3JP1	3"	10"	3000	1500	111	150	40
3MP1	3"	8"		750	99	104	4
3RP1	3"	9.12"		1000	61	86	5
3SP1	1.5x3"	9.12"		1000	61	86	5
3XP1	1.5x3"	8.875"		2000	33	80	22

The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table adjoining. These tubes are available in P1, P2, P7 and P11 phosphors. 3JP1, 3JP2, 3JP7, 3RP1, 3SP1 and 3XP1 are available as JAN tubes.

*Deflection in volts per inch.
**Light output of a line in millifoot lamberts per millimeter at line width not to exceed .65mm.

WATERMAN PRODUCTS

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PENNA., U.S.A. • CABLE ADDRESS, POKETSCOPE, PHILA.

Manufacturers of Pocketscopes® • Rakscopes® • Pulsescope® • Panelscopes® and Rayonic® Tubes

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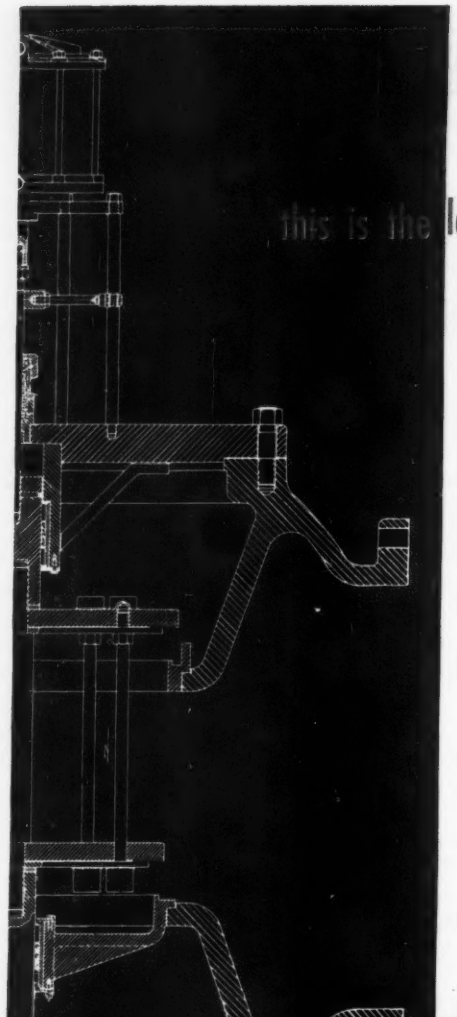


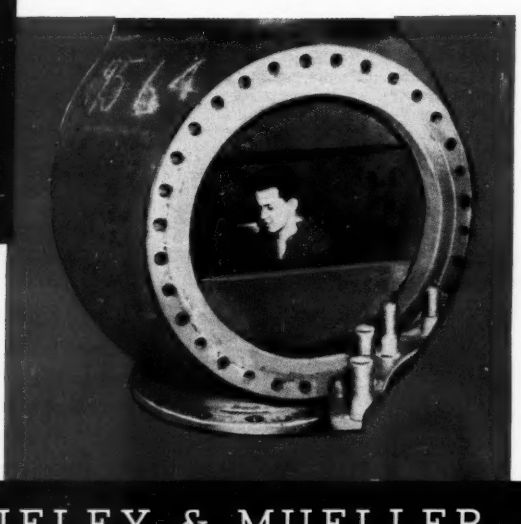
this is the largest double-seated control valve ever made

When you are talking *big* control valves, talk to Kieley & Mueller. K&M is the largest manufacturer of the big ones, control valves above 16 inches. Standard globe-type valves are available in 20, 24, 30 and 36 inch sizes; even larger valves will be produced on special order.

This 36-inch double-seated angle valve closes snugly on giant Teflon seats. The inner valve positions responsively, gliding on special roller-slide bearings. It's massive, but is operates protected by a K&M patented torque resistor. Beyond the problem of size, this valve is mounted on its side, and it has been performing creditably for over four years.

BIG or small, if it's control valves, you'll like the pitch-in, helpful approach of your local K&M representative . . . plus capable engineering and manufacturing follow-thru at the K&M plant.

Write for Bulletin CV-53.



ABOVE: Partial cross-section of K&M 36-inch valve showing general construction.

AT RIGHT: Actual size of a 36 inch valve can be visualized from this illustration of a workman inside the valve body performing finishing operations.

K&M

KIELEY & MUELLER, INC.

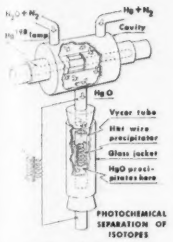
64 Genung Street • Middletown, New York

78th Anniversary . . . Oldest U.S. Pressure and Level Control Valve Manufacturer

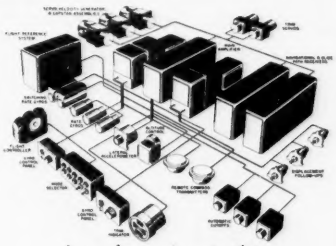
For more information circle **29** on inquiry card.

ELECTRONIC CAMERA that reproduces screened negatives is being developed by Fairchild Graphic Equipment, Inc.; 2,000 dots per second are exposed sequentially on photographic film with built-in tone controls adjusting the light beam for tailor-made plates.

PATENT awarded Dr. Bruce Billings, vp, Baird Assocs.-Atomic Instrument Co., is based on successful technique for photochemical separation of isotopes, resulting in enrichments of as much as 150%.



Billings' Patent



Lear electronic autopilots

AIR FRANCE has specified Lear electronic autopilots for all of its Caravelle jet transports—13 advanced automatic flight-control systems will be installed in the medium-range passenger aircraft now being built.

TWENTY-TON "UNIVAC" of Remington Rand was flown across the Atlantic to establish a computer service center at the Battelle Institute, Frankfurt, said to be the first such installation on the European continent.

"SIMULATION AND THEORY OF TRAFFIC FLOW" will be the subject of a two-week course given

What can you learn about

ANALOG COMPUTERS?

You can learn about . . .

Special-purpose analog computers for control of machine tools, rolling mill schedules, motor lamination production, and other specific industrial applications—includes analyzing the problem and determining the most effective computer approach—analog or digital.
Presented by Austin Company, in Room 553

Simulation and computation with the general-purpose analog computer, including practical applications on specific problems already solved—also new developments in automatic programming, setup, and checking—also new special-purpose digital computers.
Presented by Berkeley Division, Beckman Instruments, Inc., in Room 328

Setting up specific problems on the general-purpose analog computer, with emphasis on use of each element of the computer.
Presented by Electronic Associates, Inc., in Room 349

High-speed analog-to-digital conversion and data handling, featuring "DATRACS" 200,000 Conversions per second—emphasizing data sampling, band width, noise, etc.
Presented by Epsco, Inc., in Room 416

Simulation—the modern way to high-speed analysis of design, operation, and control of equipment.
Presented by Intercontinental Dynamics Corp., in Room 427

Operation and application of the general-purpose analog computer, with discussion of practical solutions for typical aircraft, process, and tunnel applications.
Presented by Reeves Instrument Corporation, in Room 333

at the **ANALOG COMPUTER CLINIC** at the Third Automation Exposition. See page 1970 for registration coupon.

MEASURE AND RECORD THE DIFFERENCE

in refractive index in non-opaque liquid streams with the

NEW PHOENIX

automatic recording differential refractometer

Instrument shown is for mass-collection laboratory use. Other models available for process use. Limiting sensitivity 3 x 10^{-6}.

With this new precision instrument, you can plot refractive index changes in any non-opaque liquid stream, such as distillate or a chromotographic eluate.

The new Phoenix Automatic Recording Differential Refractometer makes possible extremely accurate qualitative and quantitative analysis of hydrocarbons, alkaloids, steroids, antibiotics, rare earths and other materials. It thus can facilitate accurate process control in chemical, petroleum, pharmaceutical, and many related industries.

Several models available for laboratory, process applications. Even the most sensitive has a 6600-unit range, without the necessity of changing cells or reference solutions.

MAIL COUPON FOR COMPLETE INFORMATION!

PPI

PHOENIX PRECISION INSTRUMENT CO.
PHILADELPHIA 40 PENNSYLVANIA

PHOENIX PRECISION INSTRUMENT CO.
3805 N. 5th Street, Dept. 01, Philadelphia 40, Pa.
Please send complete information on your new Automatic Recording Differential Refractometer for:
☐ measurement and recording in laboratory use.
☐ measurement, recording and control in continuous process use.

Name_____
Company_____
Street Address_____ Zone_____
City_____
State_____

For more information circle **30** on inquiry card.

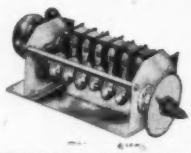
Be sure to see this modern

Zenith AUTOMATIC CONTROL EQUIPMENT

at the New York Show

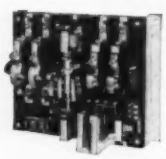
• 3RD INT'L. AUTOMATION EXPOSITION
Nov. 26-30 . . . EXHIBIT 103

ZENITH MULTI-CIRCUIT CYCLE TIMERS



Specially designed to accurately time any electrical operation. Set for on and off periods with as many circuits as desired. Furnished with synchronous motor for elevator control, limit switch, etc.

ZENITH AUTOMATIC TRANSFER SWITCHES

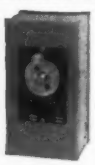


Automatic transfer to emergency source in 1/25th second . . . automatic return to normal voltage when restored. Supplied ac. or dc. Capacities up to 400 amps.

ZENITH INTERVAL TIMERS—
MANUALLY PRE-SET

No clock springs to wind or break . . . powerful, self-starting, slow-speed, synchronous motor insures dependable operation. Timing ranges from 1 minute to 120 hours. 115 and 230 volt models.

ZENITH RESET TIMERS—
AUTOMATIC, REMOTE CONTROL



Easily pre-set, automatically reset. Synchronous motor opens and closes circuits as pre-set. May be used as timer in conjunction with standard start-stop push button station.

ZENITH PROCESS TIMER—
with new PERCENTAGE CALIBRATION

For Hold Fire Control, Mixing Machinery, Testing Equipment, Fans, Heaters, etc. Wide variety of models for all types of adjustable automatic cycle timing. Total time cycle from 15 seconds to 24 hours, with range of adjustability to 94% for ON or OFF periods.

OTHER ZENITH AUTOMATIC CONTROL EQUIPMENT

*—switches, contactors, motors, relays, solenoids, etc.—*will also be on display. And all are illustrated and described in the valuable Zenith Catalog. Ask for your copy at the Exposition . . . or write direct today.

ZENITH ELECTRIC CO.
159 W. WALTON ST., CHICAGO 10, ILLINOIS

For more information circle **31** on inquiry card.

NEWS—CONTINUED

by the Univ. of Calif., and designed to give traffic engineers a working knowledge of traffic simulation techniques.

FLEXLAB VOLTAGE DISTRIBUTION SYSTEM, costing close to a million dollars, will be installed at the Army Ballistic Missile Agency, Huntsville, Ala., by Standard Electric Time Co.

NATIONAL CASH REGISTER CO. has been granted a license to manufacture printed circuits by the Technograph process.

HOSEI UNIVERSITY, 7 Sinborityo, Azabu Minato-ku Tokyo, Japan has issued a technical report written by Prof. Shin'ichiro Takeda on the "Transmission of Oscillatory Pressures through Instrument Pipe Lines."

THE PHYSICAL SOCIETY, London, England has published a report on their meeting on Semiconductors held in collaboration with British Thomson-Houston Ltd. Report covers conduction in the impurity band junction rectifier theory, a semiconductor bond, etc.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York.

New York Stock Exchange:

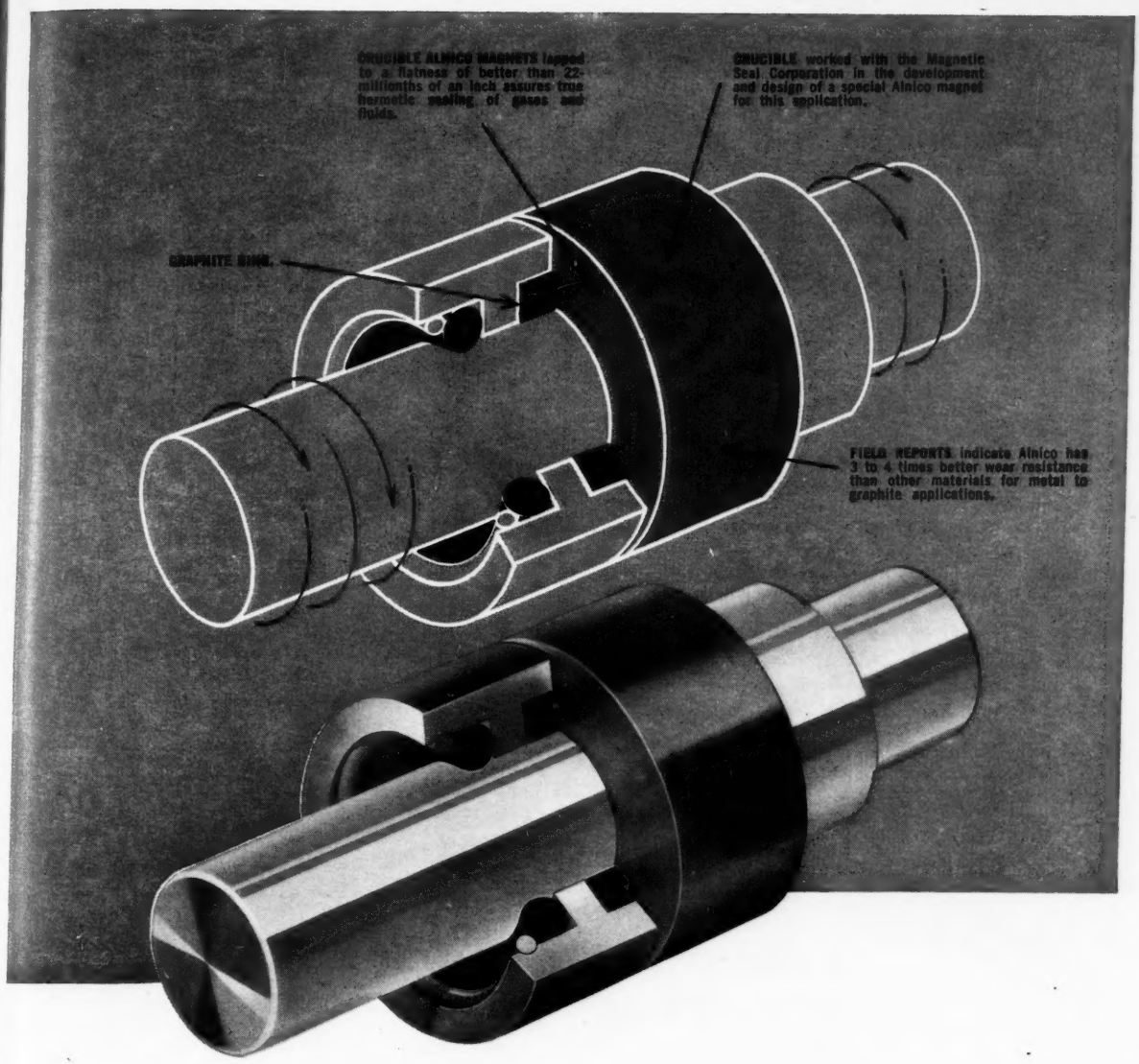
Security	Price Range for 1956 Thru July 31 High	Low	As of July 31 Last
Aeroquip	15 3/8	11 7/8	14 3/8
American Chain & Cable	51 7/8	38 1/2	49 1/8
American Mach. & F.	32 1/8	24 1/8	28 3/8
American Mach. & M.	40 3/4	35 1/8	38 3/4
American Optical	40 3/4	34 1/2	36 1/4
Beckman Instruments	37 5/8	25 1/8	36 1/2
Bell & Howell	45 1/2	28 1/4	40 3/4
Bendix Aviation	63	48 1/2	53 3/4
Bulova Watch	23	20 1/4	21 1/4
Burroughs	44 3/4	28 1/2	42 7/8
Clevite	24 1/4	18	19
Dobeckman	39 1/4	31 1/4	32
Gamewell	32 3/8	25 5/8	32 1/4
General Inst.	10 1/8	7 3/8	7 5/8
General Prec.	53 1/2	37 1/2	43 1/4
General Time	33 1/8	29 1/2	32
Hamilton Watch	25 3/4	19	25 1/2
International Business Mach.	523	400	515
Minneapolis-Hon.	90 1/2	58	87 5/8
National Cash Reg.	59	34 1/8	55 3/4
Radio Corp.	50 3/8	41 1/8	42 3/4
Raytheon	19 1/2	13	13 7/8
Robertshaw-F.	28 3/8	21 1/2	23 3/8
Sangamo Electric	37 1/2	29 1/2	35 3/4
Sperry Rand	29 1/8	23 5/8	26 3/4
Square D	82	51 1/2	79 1/4
Starrett, L. S.	56 1/2	43 3/4	54 - 54 5/8 (1)
Sylvania Electric	55 7/8	42	53
Telautograph	15 1/4	11	13 1/2
Texas Inst.	15 1/8	11 5/8	13 1/2
Underwood	44	28 3/4	30 1/4

(1) Bid - Asked price, no sale.

American Stock Exchange:

Security	Price Range for 1956 Thru July 31 High	Low	As of July 31 Last
Air Assoc.	13 1/2	9	9 7/8 - 10 (1)
American Meter	41	33	35 7/8
Benrus Watch	10 3/8	8 1/4	8 1/4
Breeze Corp.	9 1/8	6 1/8	6 1/4
Consolidated Electrodynamics	32 1/2	21	32
DuMont Labs.	10	5 3/4	6 1/2
Fairchild Camera & Instr.	25 7/8	19 1/2	24 3/8
Int'l Resistance	8 1/4	5 5/8	5 7/8
Lear Inc.	10 1/4	7 1/2	7 3/4
Nat'l Rea. Corp.	29 3/4	17 7/8	22 7/8
Neptune Meter	36	28 3/8	35 1/4
New Haven Clock	2 1/2	1 1/2	1 1/2 - 1 3/4 (1)
Norden-Ketay	14 7/8	9 5/8	9 7/8
Pneumatic Scale	28 1/4	24	25 1/4
Servomechanisms	10 3/8	8 1/4	9 7/8
Wallace & Tiernan	22 1/2	19 1/2	20 3/8
Waltham Watch	3	1 1/4	1 1/2

(1) Bid - Asked price, no sale.


CRUCIBLE ALNICO MAGNETS lapped to a flatness of better than 22-millionths of an inch assures true hermetic sealing of gases and fluids.
CRUCIBLE worked with the Magnetic Seal Corporation in the development and design of a special Alnico magnet for this application.
GRAPHITE RING.
FIELD REPORTS indicate Alnico has 3 to 4 times better wear resistance than other materials for metal to graphite applications.

in magnetic seals, too

CRUCIBLE PERMANENT MAGNETS

mean maximum energy—minimum size

The consistently higher energy product of Crucible Alnico magnets allows smaller parts—greater compactness in special applications like this magnetic shaft seal. What's more, the superior corrosion and wear resistance of Crucible Alnico insures far greater service life.

You can regularly get Crucible permanent Alnico magnets sand cast, shell molded, or investment cast to exact size, shape or tolerance requirements . . . and in any size from a mere fraction of an ounce to hundreds of pounds. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

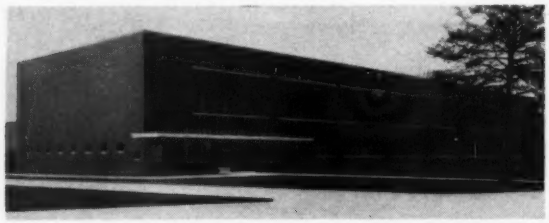
CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

For more information circle **32** on inquiry card.

New Plants and Mergers

BAILEY METER CO. announces a new two-story addition to their new plant in Wickliffe, Ohio, to be completed in July, 1957.



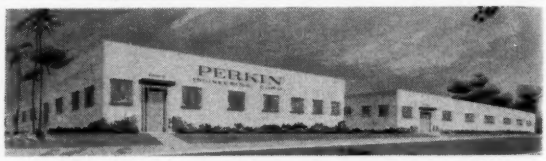
HELIPOT DIV., BECKMAN INSTRUMENTS, INC., announces completion of its move from S. Pasadena to temporary quarters in Costa Mesa until their new $2 million Newport Beach plant is ready.

GENERAL ELECTRIC CO. announces merging of its industrial computer sales force into a national organization with headquarters in Syracuse, N. Y.—GE's Advanced Electronics Center at Cornell Univ. will become a part of the Light Military Electronic Equipment Dept. at Utica, N. Y.

ALLEN B. DU MONT LABS., INC., announces a new TV-Transmitter Dept. to concentrate on electronic scanning systems and industrial television.

CONTINENTAL CARBON, CLEVELAND, announces the procurement of the Wirt Co., Philadelphia, by Continental's directors.

PERKIN ENGINEERING CORP., El Segundo, Calif., announces acquisition of a new building adjacent to their



present location for production of power supplies and voltage regulators.

DAYSTROM, INC., announces formation of Daystrom Systems Div. to design, build, test and install complete systems for automation applications.

AMERICAN MACHINE & FOUNDRY CO., Turbo Div., recently dedicated a new 66,000 sq ft advanced research and development center at Pacoima, Calif.

MINNEAPOLIS-HONEYWELL REGULATOR CO. announces purchase of the Hathaway plant in Boston to house Honeywell's Transistor Div., and plans to erect a

COMPUTING ENGINEERS
APPLIED MATHEMATICIANS
(All Levels)

New Opportunities in Republic Aviation's Expanding Computer Program

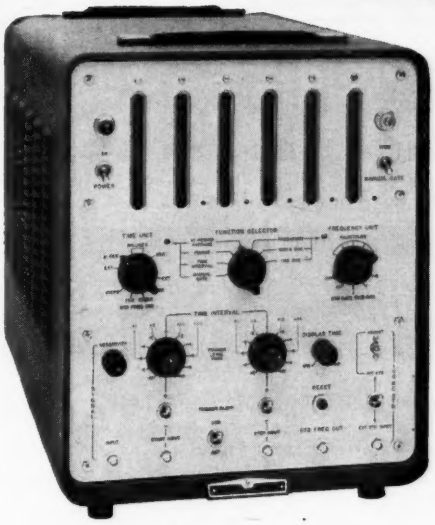
A new, air-conditioned installation is under construction at Republic to house the equipment and personnel of its rapidly expanding Digital Computing Section.

Enjoy the opportunities that go with a wide range of complex problems in the design and manufacture of supersonic aircraft and guided missiles as we plan the progressive expansion of this installation in 3 phases. Positions are open at various levels, including supervisory.

You can capitalize on these opportunities if you have at least 2 years experience programming for digital computers, along with a sound background in mathematics – opportunities to enjoy varying degrees of responsibility where your knowledge of digital computing equipment, mathematical procedures and numerical techniques can be utilized for maximum efficiency.

Please send resume in confidence to: **Mr. D. G. Reid**
Engineering Personnel Manager
REPUBLIC AVIATION
Farmingdale, L. I., New York

Direct readings of



FREQUENCY
TIME
PERIOD

New hp 523B
ELECTRONIC COUNTER

10 cps to 1.1 MC!

- **Extreme dependability**
- **Etched, unitized circuits**
- **Permits viewing time-interval start and stop points on oscilloscope**
- **High accuracy crystal oscillator circuit**
- **Trouble-localizer lights**
- **Counts pulses of selected voltage level**

Construction of the new *-hp-* 523B is highest quality throughout. Etched circuits are rugged, ultra-dependable. Circuits are arranged for complete visibility. Trouble-localizer lights and plugs disconnecting circuit elements further simplify maintenance.

Exclusive features include a pulse output for oscilloscope Z-axis modulation permitting visual identification of the time-interval start and stop points on the input waveform measured. There is also a pulse count discriminator counting only pulses of voltage above a pre-determined level; and a high accuracy, high stability crystal controlled oscillator. Controls are color-coded, concentric, functionally arranged. Readings are direct in clear, bright numerals; decimal is automatic and illuminated.

The broad range and versatile usefulness of *-hp-* 523B is indicated by the Specifications at right. Model 523B is designed for utmost speed and simplicity in measuring production quantities, rpm, nuclear pulses, power line frequencies, repetition rates, time intervals, pulse lengths, shutter speeds, velocities, relay times, frequency ratios, phase delay, etc. With transducers, *-hp-* 523B also provides local or remote measurement of weight, pressure, temperature, acceleration, etc.

BRIEF SPECIFICATIONS

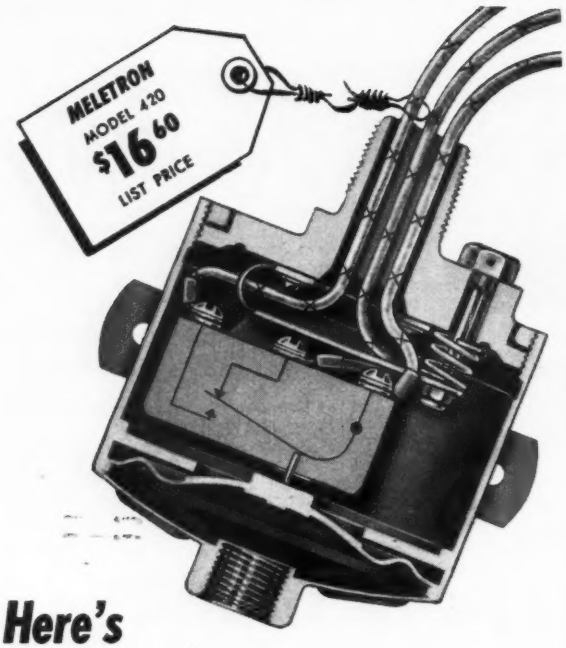
FREQUENCY MEASUREMENT:	
Range:	10 cps to 1.1 MC
Accuracy:	± 1 count ± crystal stability
Input Minimum:	0.2 v RMS
Input Impedance:	Approx. 1 megohm, 30 μμf shunt
Gate Time:	0.001, 0.01, 0.1, 1, 10 seconds
Reads Directly In:	KC. Automatic decimal
PERIOD MEASUREMENT:	
Range:	0.00001 cps to 10 KC
Accuracy:	±0.3% (1 period); ±0.03% (10 periods)
Input Minimum:	1 v RMS
Input Impedance:	Approx. 1 megohm, 40 μμf shunt
Gate Time:	1 or 10 cycles of unknown
Standard Counting:	10 cps, 1 KC, 100 KC, 1 MC, External
Reads Directly In:	Sec, msec, μsec; automatic decimal
TIME INTERVAL MEASUREMENT:	
Range:	3.0 μsec to 100,000 sec (27.8 hrs)
Accuracy:	±1/ std. freq. counted ± stability
Input Minimum:	1 v peak. dc coupled
Input Impedance:	Approx. 1 megohm, 25 μμf shunt
Trigger Slope:	Pos. or neg. on start/stop independent or common channels
Trigger Amplitude:	−300 to +300 v adjustable
Standard Counting:	10 cps, 1 KC, 100 KC, 1 MC, External
Reads Directly In:	Sec, msec, μsec, automatic decimal
STABILITY:	2/1,000,000 per week. Also WWV
DISPLAY TIME:	Variable 0.1 to 5 sec, or indefinite
OUTPUTS:	Secondary standard: 10 cps, 1 KC rectangular, 100 KC, 1 MC sine wave.
PRICE:	$1,175.00

Data subject to change without notice. Price f.o.b. factory.

HEWLETT-PACKARD COMPANY
3695C Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 5-4451
Field engineers in all principal areas

hp complete coverage in quality counters

For more information circle **33** on inquiry card.



Here's the Simplest Diaphragm Pressure Switch

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

To get complete specifications and operating data ask for bulletins 420-421

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

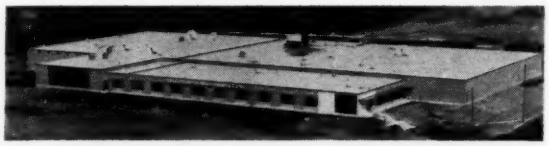
5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **34** on inquiry card.

PLANTS—CONTINUED

$4-million plant near St. Petersburg, Fla., to develop and produce inertial-guidance navigation equipment.

BALDWIN-LIMA-HAMILTON CORP. has opened a new $3 million plant at Waltham, Mass., to house its entire Electronics Instrumentation Div. under one roof.



AUTOMATIC ELECTRIC CO., CHICAGO, announces revised estimates of expected demand for their dial telephones and other electronic products has prompted an increase of 200,000 sq ft in their new manufacturing and research center now under construction.

BERKELEY DIV., Beckman Instruments, has completed the $500,000 building program initiated last October which doubles the size of the Richmond, Calif. facilities.

What's the latest in

PROCESS AUTOMATION?

You can learn about . . .

COC (Centralized Operations Control) techniques, with demonstrations of systems built up from COC subsystem elements.
Presented by Hammarlund Manufacturing Company, in Room 551

Control applications of "Dynamaster" high-speed potentiometer equipment.
Presented by The Bristol Company, in Room 301

Automatic control systems for process variables, including load, pressure, torque, etc.
Presented by Baldwin-Lima-Hamilton Corp., in Room 542

"Rotameter" flow measurement and control.
Presented by Brooks Rotameter Company, in Room 532

Equipment applications and techniques used in automatic data logging—and appraisal of promising future developments.
Presented by Fischer & Porter Company, in Rooms 430, 444

Installation and operation of centrallized control of integrated, remote, field operations.
Presented by Panellit, Inc., in Rooms 529, 530

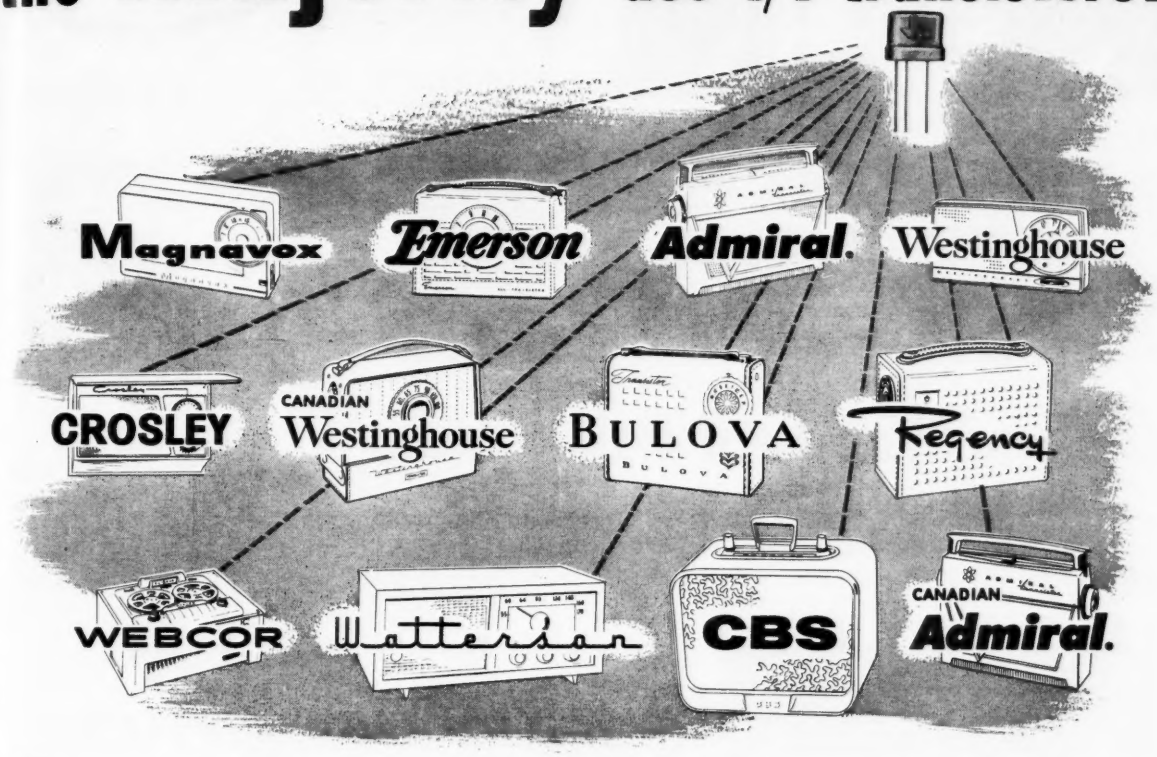
Selection and application criteria for pressure switches.
Presented by Gorn Electric Co., Inc. in Room 544

Investigation of valve system performance factors, e.g. capacity, erosion, tight shut-off, and high-speed operation; with description of Paul Venturi Ball Control Valve.
Presented by P-K Industries, Inc., in Room 526

at the **PROCESS AUTOMATION CLINIC** at the Third International Automation Exposition. See page 1970 for registration coupon.

TI PROGRESS REPORT ON RADIO TRANSISTORIZATION

the majority use T/I transistors!



The overwhelming majority of transistorized radios — including these and other brands—use Texas Instruments transistors. This is simple proof of TI's leadership in research, development, and manufacture of transistors.

The constantly growing line of economical TI transistors — high in gain, frequency, power, and reliability — offers *your* transistorization program increasing design freedom and flexibility.

ALL THESE UNITS ARE IN PRODUCTION AND IMMEDIATELY AVAILABLE!

VHF GERMANIUM TETRODE — Maximum oscillation frequency above 250 mc; typical amplifier gain, 12 db at 100 mc. A "grown-diffused" product!

GERMANIUM POWER TRANSISTOR — For Class A and B amplifiers; low distortion, linear beta, high current capacity.

GERMANIUM HF TRANSISTOR — Converter in 455 kc commercial receivers; conversion gain, 22 db minimum at 1800 kc input.

GERMANIUM AUDIO OUTPUT TRANSISTOR — Designed for driver and Class B audio applications; low distortion, linear beta.

GERMANIUM IF AMPLIFIER TRANSISTORS — High gain in common emitter applications. In 262 kc and 455 kc types; all with fixed value of neutralizing impedance.

GENERAL PURPOSE GERMANIUM TRANSISTORS — Three types for general application; featuring narrow beta spread.

LOOK TO TI FOR: GERMANIUM VHF, POWER, RADIO, AND GENERAL PURPOSE TRANSISTORS
SILICON HF, POWER, AND SMALL SIGNAL TRANSISTORS • SILICON DIODES AND RECTIFIERS

pioneer producer of radio transistors!

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **35** on inquiry card.

CONSOLIDATED ELECTRODYNAMICS CORP. announces appointment of *Holley B. Dickinson* as assistant to the president.

H. B. Dickinson
CEC

L. L. Forward
Taylor

TAYLOR INSTRUMENT COS. announce appointments of *L. Lawrence Forward* as general sales manager, and *Albert J. Fleig* as assistant sales manager. Present general sales manager *Frank S. Ward* is named administrative assistant to the president.

TECHNICAL WRITING IMPROVEMENT SOCIETY, Los Angeles, Calif., announces election of *John L. Kent,* chief of the Editorial Bureau of Consolidated Electrodynamics Corp., as president.

SERVOMECHANISMS, INC., announces appointment of *Najeeb E. Halaby* as vp in charge of company development, and *Thurman C. Erickson* as industrial relations director.

Edward M. Bieber

EDWARD M. BIEBER, vice-president, American Laubscher Corporation, died on Wednesday, August 15, 1956.

People IN THE NEWS

BARBER-COLMAN CO. announces appointment of *H. H. Kieckhefer* as sales manager of Wheelco Instruments Div.

H. H. Kieckhefer
Barber-Colman

O. B. Wilson
M-H

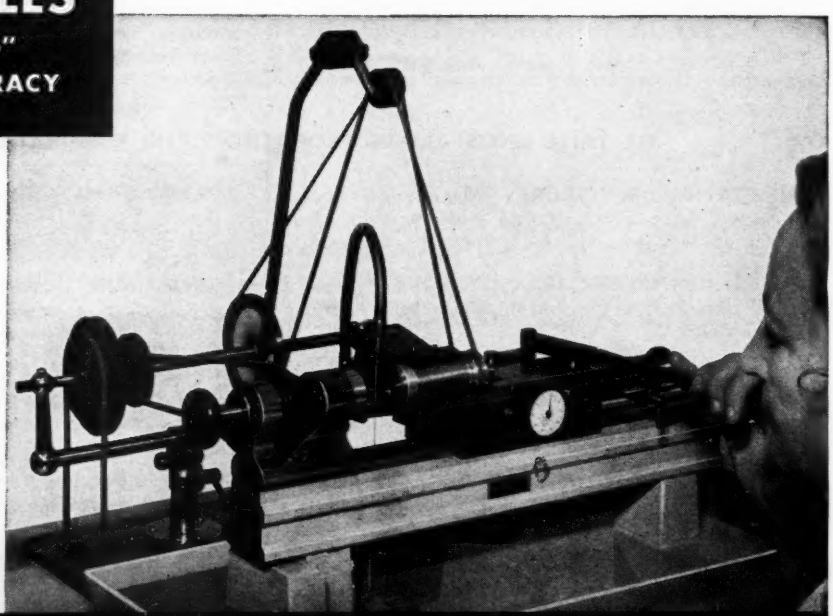
MINNEAPOLIS-HONEYWELL REGULATOR CO. announces appointment of *O. B. Wilson* as VP, Brown Instruments Div.

BURROUGHS CORP. has named *Dr. Irven Travis* vp of research and engineering, and *U. Clarke S. Dilks* manager, Research Div.

CLIFTON PRECISION PRODUCTS CO., INC., announces appointment of *H. Thomas Larkins* as eastern sales manager.

DRILL MICRO-HOLES
DOWN TO .0016"
with SPEED & ACCURACY

ON *LEVIN* ® INSTRUMENT LATHES

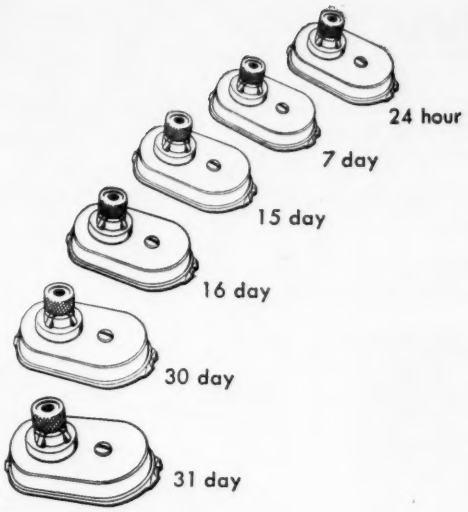


The Levin micro-drilling equipment shown here can be used with the smallest drills available. It is designed so that the drilling does not depend on the operator's sense of feel. The drill can be retracted for chip removal and returned to the drilling position without striking the bottom of the hole. While commercial drills can be had as small as .0016" this micro-drilling apparatus has successfully produced holes as small as .0006".

Send for Catalog M describing complete line of instrument lathes and accessories.

LOUIS LEVIN & SON, INC.—3610 S. BROADWAY—LOS ANGELES 7, CALIFORNIA

For more information circle **36** on inquiry card.



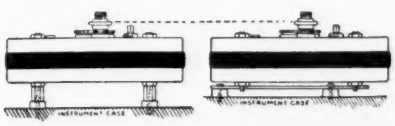
New ROCKWELL
31 DAY CHART DRIVE

For Complete Records Around The Clock

The turret on top does the trick

Stops Estimating Even though your meter man forgets to wind it, this new Rockwell 31 day drive will still provide a complete rotation for the chart period.

Saves Money The six different rotation rates (as illustrated) assure complete flexibility in your measurement program. You'll save through making less trips to the meter; having fewer charts to read.

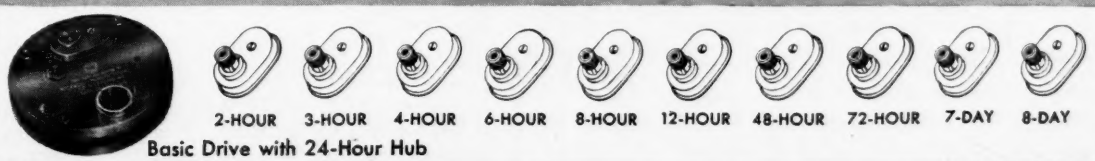


Fits Practically All Instruments The case dimensions are the same as the Rockwell Standard Chart Drive. Simple adaptors, as shown above, permit correctly locating it both as to position and height in practically any instrument.

ROCKWELL MANUFACTURING COMPANY
Instrument Division • Box 2396, Tulsa, Okla.

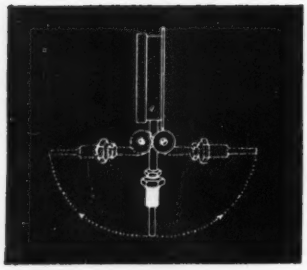
Atlanta Boston Charlotte Chicago Dallas Denver Houston Los Angeles
Midland, Tex. New Orleans New York N. Kansas City Philadelphia Pittsburgh
San Francisco Seattle Shreveport Tulsa

ALSO STANDARD ROCKWELL CHART DRIVES, 24 Hour Hub, 11 Rotations

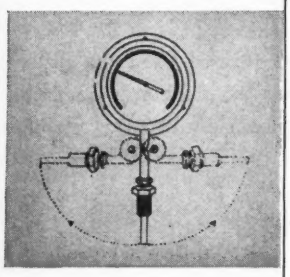


Basic Drive with 24-Hour Hub

For more information circle **37** on inquiry card.



You get dependability PLUS with Moeller dial indicating (mercury actuated) thermometers

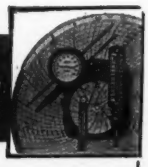


because—since 1867 our business has been the design and manufacture of temperature measuring instruments.

Up or down—left or right, you can easily install Moeller adjustable form dial indicating thermometers at any advantageous reading angle.

For further details, mail the coupon, today!

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE.
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities



Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Dial Indicating Thermometers.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE..... STATE.....

For more information circle **38** on inquiry card.

PEOPLE—CONTINUED

FAIRCHILD CAMERA AND INSTRUMENT CORP. announces appointment of *Raul H. Frye* as general manager of the Electronics Division.

BRUSH ELECTRONICS CO. announces appointment of *Joseph Foster* as manager, market research dept.

EPSCO, Inc., announces appointment of *Arthur L. Munzig, Jr.,* as sales manager.

A. L. Munzig, Jr.
Epsco

L. P. Skinner
Process Sales

PROCESS SALES CO., Beaumont, Texas, has been formed recently by *L. P. Skinner, Jr.,* as an engineering and sales agency for manufacturers of industrial instrumentation and chemical process equipment.

NATIONAL BUREAU OF STANDARDS—*Harvey W. Lance* has rejoined the NBS staff as chief of the calibration center at NBS Boulder Labs.

FISHER GOVERNOR COMPANY has named *Jack M. Smither & Co.* sales representative for Georgia, Fla., and eastern Tennessee.

What's new in

OFFICE AUTOMATION AND DATA-HANDLING?

You can learn about . . .

Large-scale office procedures and systems implemented by automatic data processing machines.
Presented by Remington Rand Div., Sperry Rand Corp., in Rooms 534, 537

Special-purpose "Magnetronic" systems for automatic banking, automatic reservation handling, automatic stock exchanges, automatic inventory, etc.
Presented by Teleregister Corporation, in Room 436

Large-scale data handling for industry and finance, including point-of-action data pick-up and media transfer systems.
Presented by Underwood Corporation, in Room 429

Applications for semi-automatic and fully automatic pneumatic tube systems for transferring data and documents, including demonstrations of operating systems.
Presented by International Standard Trading Corporation, in Room 527

Ormig selective data printers, which break down data from lists and print on single-item tickets, also select and print lines, columns, headings.
Presented by Copy-Craft, Inc., in Room 327

Digital data recording and handling, including a new random-access memory of high capacity for business applications.
Presented by Potter Instrument Company, Inc., in Room 549

Central control systems with automatic data handling, including programming, logging, etc. Emphasis on process data.
Presented by Fischer & Porter Company, in Rooms 430, 444

Automatic data logging and control centers for industrial operations.
Presented by Panellit, Inc., in Rooms 529, 530

Statistical Analysis.
Presented by Electronic Control Systems, Inc., in Room 507

at the **OFFICE AUTOMATION and DATA-HANDLING CLINIC** at the Third Automation Exposition. See page 1970 for registration coupon.

Klipfel

GOLDEN GENIE

TEMPERATURE REGULATOR

Self-actuated

Vapor Pressure Type

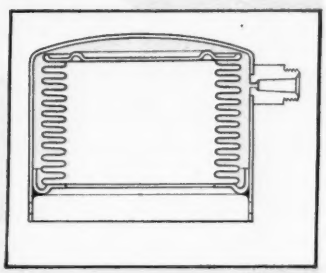
Emergency manual control override

Accurate temperature adjustment

. . . precision control at your command

Modern design and skilled craftsmanship are combined in the new Klipfel Golden Genie to assure accurate, positive, low cost temperature control. Featuring strong, long lasting 2-ply bellows, it operates at higher working pressure with smaller bulb, develops more power for valve actuation.

For full details on the Golden Genie and the complete line of Klipfel Valves, write to Dept. D-10.

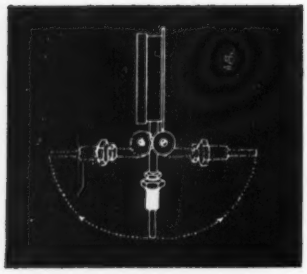


Rugged 2-ply Double Wall Bellows . . . Vapor pressure cup construction gives added strength. Cannot be over-extended. High pressure small bulb operation develops more power.

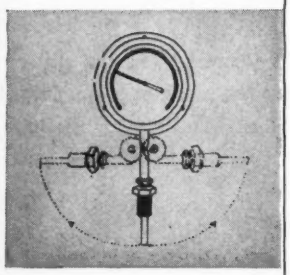
Klipfel VALVES, INC.

Division of Hamilton-Thomas Corp.
Hamilton, Ohio

Export Dept.—1010 Schaff Bldg. Philadelphia, Pa.



You get dependability PLUS with Moeller dial indicating (mercury actuated) thermometers

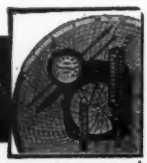


because—since 1867 our business has been the design and manufacture of temperature measuring instruments.

Up or down—left or right, you can easily install Moeller adjustable form dial indicating thermometers at any advantageous reading angle.

For further details, mail the coupon, today!

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE. RICHMOND HILL 18, N. Y.
Representatives in Principal Cities



Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Dial Indicating Thermometers.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE..... STATE.....

For more information circle **38** on inquiry card.

PEOPLE—CONTINUED

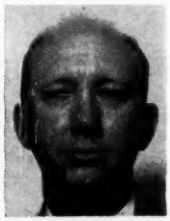
FAIRCHILD CAMERA AND INSTRUMENT CORP. announces appointment of *Raul H. Frye* as general manager of the Electronics Division.

BRUSH ELECTRONICS CO. announces appointment of *Joseph Foster* as manager, market research dept.

EPSCO, Inc., announces appointment of *Arthur L. Munzig, Jr.,* as sales manager.

A. L. Munzig, Jr.
Epsco

L. P. Skinner
Process Sales



PROCESS SALES CO., Beaumont, Texas, has been formed recently by *L. P. Skinner, Jr.,* as an engineering and sales agency for manufacturers of industrial instrumentation and chemical process equipment.

NATIONAL BUREAU OF STANDARDS—*Harvey W. Lance* has rejoined the NBS staff as chief of the calibration center at NBS Boulder Labs.

FISHER GOVERNOR COMPANY has named *Jack M. Smither & Co.* sales representative for Georgia, Fla., and eastern Tennessee.

What's new in

OFFICE AUTOMATION AND DATA-HANDLING?

You can learn about . . .

Large-scale office procedures and systems implemented by automatic data processing machines.
Presented by Remington Rand Div., Sperry Rand Corp., in Rooms 534, 537

Special-purpose "Magnetronic" systems for automatic banking, automatic reservation handling, automatic stock exchanges, automatic inventory, etc.
Presented by Teleregister Corporation, in Room 436

Large-scale data handling for industry and finance, including point-of-action data pick-up and media transfer systems.
Presented by Underwood Corporation, in Room 429

Applications for semi-automatic and fully automatic pneumatic tube systems for transferring data and documents, including demonstrations of operating systems.
Presented by International Standard Trading Corporation, in Room 527

Ormig selective data printers, which break down data from lists and print on single-item tickets, also select and print lines, columns, headings.
Presented by Copy-Craft, Inc., in Room 327

Digital data recording and handling, including a new random-access memory of high capacity for business applications.
Presented by Potter Instrument Company, Inc., in Room 549

Central control systems with automatic data handling, including programming, logging, etc. Emphasis on process data.
Presented by Fischer & Porter Company, in Rooms 430, 444

Automatic data logging and control centers for industrial operations.
Presented by Panellit, Inc., in Rooms 529, 530

Statistical Analysis.
Presented by Electronic Control Systems, Inc., in Room 507

at the **OFFICE AUTOMATION and DATA-HANDLING CLINIC** at the Third Automation Exposition. See page 1970 for registration coupon.

Klipfel

GOLDEN GENIE

TEMPERATURE REGULATOR

Self-actuated

Vapor Pressure Type

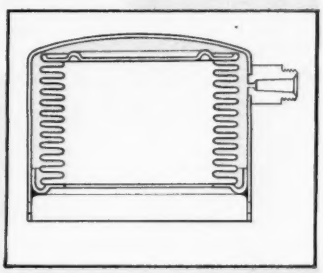
Emergency manual control override

Accurate temperature adjustment

. . . precision control at your command

Modern design and skilled craftsmanship are combined in the new Klipfel Golden Genie to assure accurate, positive, low cost temperature control. Featuring strong, long lasting 2-ply bellows, it operates at higher working pressure with smaller bulb, develops more power for valve actuation.

For full details on the Golden Genie and the complete line of Klipfel Valves, write to Dept. D-10.



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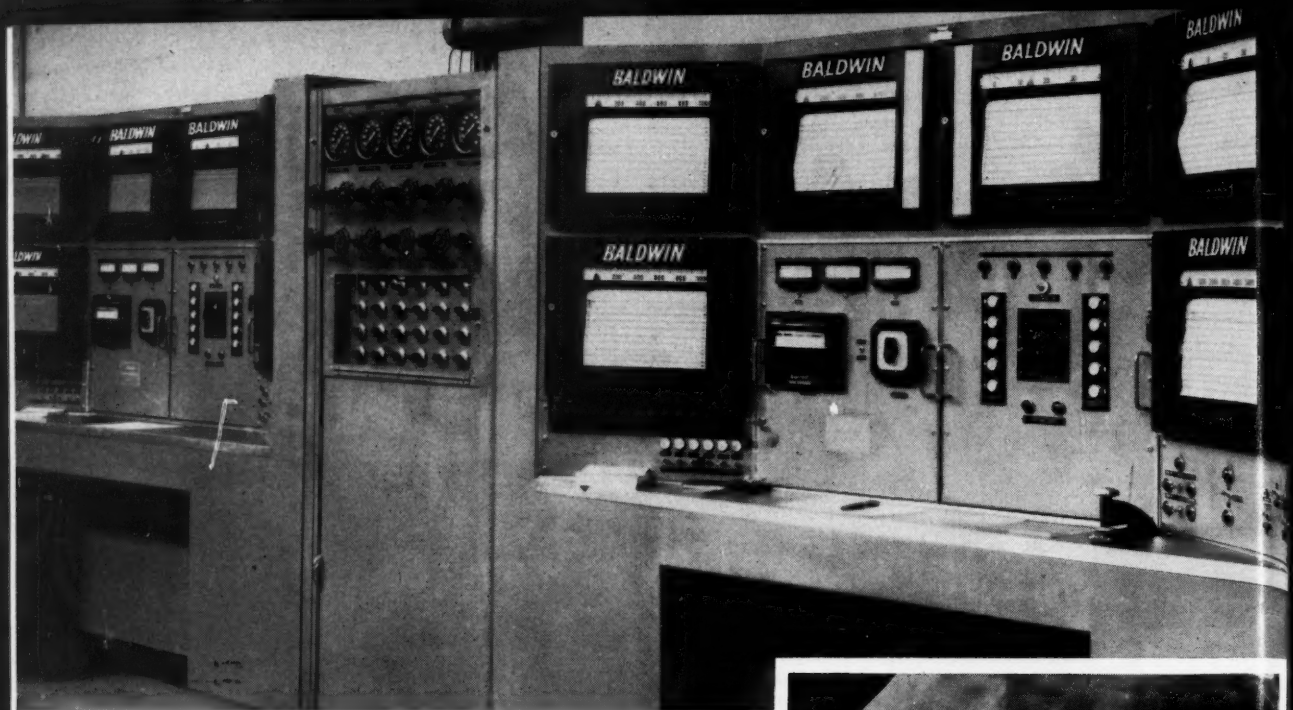
Philadelphia, Pa.

For more information circle **39** on inquiry card.

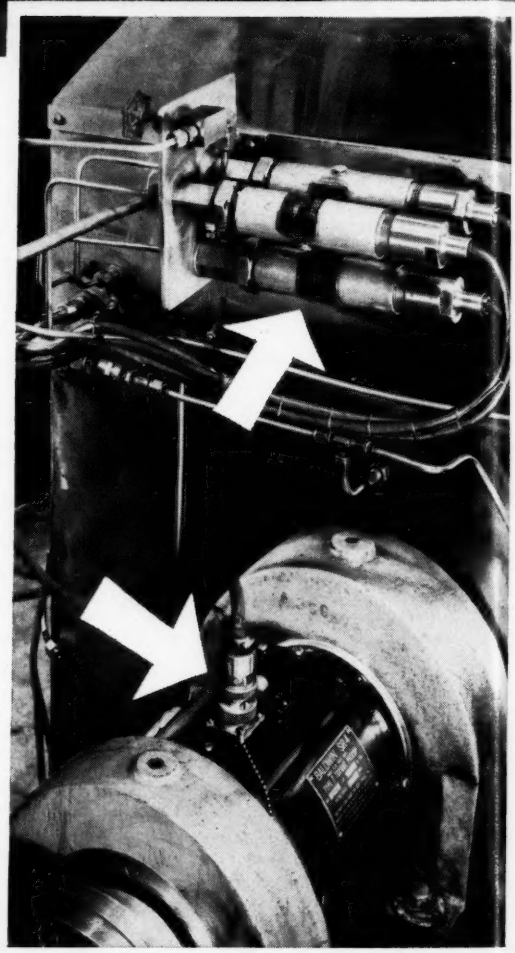


jet engine starter performance plotted quickly and accurately by Baldwin SR-4® system

Under simulated operating conditions, turbine type fuel-air combustion starters for jet aircraft engines are performance-tested by a Baldwin instrumentation system that is instantaneously responsive and accurate to .1%.

Starter operating characteristics are measured by three Baldwin SR-4 strain gage type pressure cells (at top of photo at right) and an SR-4 torque pickup (below) which follow variations in combustion pressure, fuel pressure, air pressure and torque. Electrical signals are transmitted from the cells and plotted on Baldwin recorders mounted in control consoles (photo above). Also plotted are primary ignition voltage and shaft speed. With this instrumentation system one test engineer can conduct 3½ second test runs on a continuous basis.

If *you* need to measure torque, pressure, load, tension or thrust, Baldwin can custom-design and build a system to do the job. "Packaged" systems and component transducers are also available. For illustrated bulletins, write us at Dept. 3153, Waltham, Massachusetts.



SEE OUR EXHIBIT AT THE AUTOMATION SHOW

BALDWIN BLH LIMA-HAMILTON

ELECTRONICS & INSTRUMENTATION DIVISION

BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Hamilton • Lima • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works

For more information circle **40** on inquiry card.

Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Sales Volume of Planimeters

Reader is trying to establish figures of the annual sales volume of planimeters in U.S. included in the Census of Manufacturers factory shipments under "Surveying and Drafting Instruments." A-144

Identity of Pyrometer

Engineer in fuel burning equipment and controls manufacturing company would like to identify pyrometer marked "K & S, Made in Germany." Pyrometer has 2¼" dia, is 6" long, and has pointer to be set at room temperature which gives reading on scale after training eyepiece on fire. A-145

Load Cells

Engineer in paper machinery manufacturing plant seeks addresses of manufacturers of load cells. A-146

Shaft Speed Indication

Engineer in rayon manufacturing plant seeks mechanical differential unit for indication of input shaft speeds without power transmission. Unit not larger than 4"x4"x4" is desired. Shaft speeds approximately 230 RPM. A-147

Nylon Stock Gears

President of scientific instrument company seeks names of companies stocking nylon gears particularly worm gears. A-148

Noisemeter

Engineer in pump manufacturing plant seeks noisemeter to detect noise in pipelines caused by pumps. A-149

Micron Particle Separator

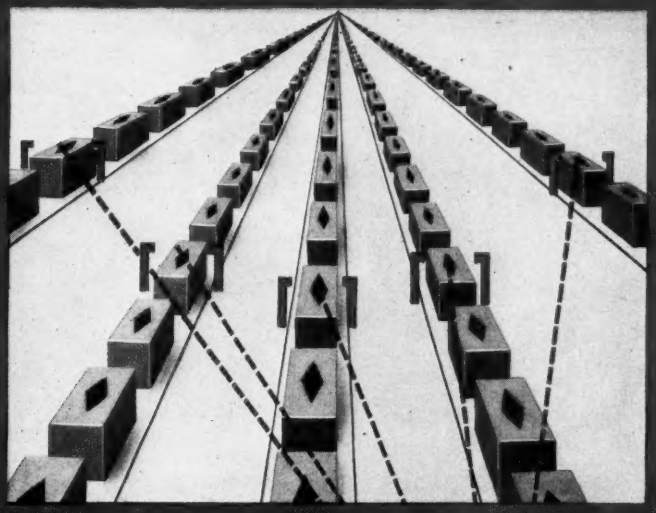
Jewelry manufacturer seeks supplier of micron particle separator. A-150

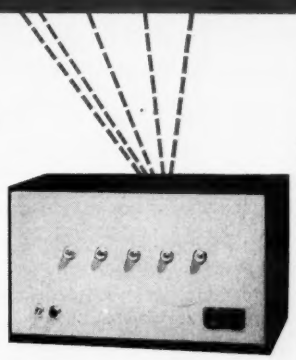
Telemetering Pickups—Terminology

Engineering department member of manufacturer of pressure transducers seeks information on standard terminology for specifying pressure pickups, in particular the definition of percent non-linearity of a pickup. A-151

MULTI PRODUCTION LINES NEED:

POST multi-channel counters





New . . . Post's multi-channel counters answer industry's need for a "total" count from several production lines *at any given moment.* Working in conjunction with a Post DECITRON electronic counter, the multi-channel system requires a photohead for each production line . . . relayed signals are tabulated by the MC and transferred to the counter instantly for visual evidence of "total".

MC—MULTI CHANNEL INPUT UNIT

Post also manufacture a variety of photo electric relays and industrial timers ideally suited to multi-production control systems. Write for descriptive literature.

POST

Electronic Products Division

POST MACHINERY CO.

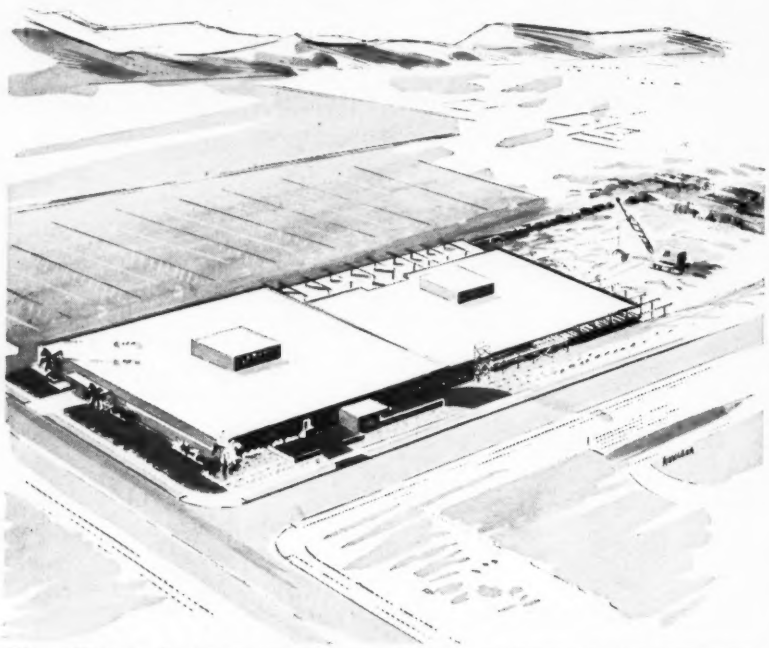
169 Elliott Street

Beverly, Mass.

For more information circle **41** on inquiry card.

ElectroData
IS EXPANDING...

Headquarter facilities in Pasadena are *again* being doubled to keep pace with the demand for DATATRON systems.



ElectroData is the fastest growing manufacturer of electronic data processing machines, and has immediate openings for:

CUSTOMER SERVICE ENGINEERS
SYSTEM EVALUATION ENGINEERS

Desirable qualifications are a degree in electrical engineering or graduate of an accredited industrial electronics school. Military radar experience or maintenance of digital computers or complex electronic equipment may be substituted for academic training.

Customer Service Engineers will be in charge of an ElectroData data processing installation. These positions exist nation-wide.

Systems Evaluation Engineers will supervise an engineering team in the final checkout and evaluation of digital computer systems.

ElectroData policy is to pay *top salaries* to men of proven capabilities. Company benefits are liberal and include:

- **Comprehensive Insurance and Retirement Program.**
- **Personal recognition.**
- **Extensive training program.**
- **Relocation expense.**
- **Salary and expense during training.**

In confidence write:

MR. LEO THOMAS
Engineering Coordinator

ElectroData DIVISION OF BURROUGHS

460 SIERRA MADRE VILLA, PASADENA, CALIFORNIA

INQUIRIES—CONT.

Neon Lamps for Computers

Consultant for company furnishing electric protection services seeks information on long-life neon lamp types used in the computer industry as storage devices. A-152

Name Plates

Vice president of pulp and paper manufacturing company seeks names and addresses of "printers who specialize in printing for various types of panels and controls." A-153

Correspondence Course

Engineer in Canadian power station seeks correspondence course in automation and electronics. A-154

Instrumentation Books and Courses

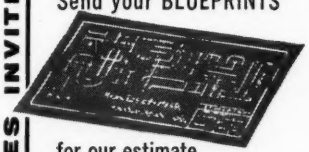
Engineer in test department of development and engineering company wishes to get information on books and educational courses on instrumentation methods, setups, repair, calibration, and the like. A-155

Portable Acceleration Recorder

Chief test engineer of aircraft company seeks portable self-contained recording accelerometer to be enclosed in containers when shipping cross country. A-156

INQUIRIES INVITED

Send your BLUEPRINTS



for our estimate on precision glass apparatus for research and control . . . made for your specific needs. Ground and graduated ware, thorough annealing. Hard, soft, lead or any grade glass desired.

L.G. NESTER COMPANY, INC.
DEPT. B
MILLVILLE • NEW JERSEY

For more information circle **42** on inquiry card.

It will take still more years of testing —at 1.89 x 10^9 operations a year— to fix the life span of this relay

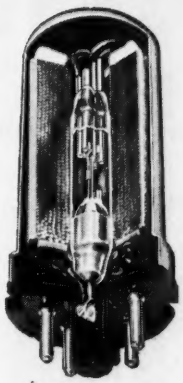
When we first claimed a life of a billion operations for CLARE *Mercury-wetted Contact Relays, we were guilty of a serious understatement.*

Here is the proof:

A life test was started in January, 1955. The relays on test are carrying a contact load of 5 amperes at 50 volts d-c (resistive load). A suitable spark suppressor is employed.

These relays have been operating continuously at a rate of 5,184,000 operations a day ever since, without any attention whatsoever.

As this is written they are closely approaching the 3 billion mark, with every indication they will go on operating for years.



Think of it! Here is a relay that in normal service will outlast a man's lifetime!

Have you a job for which none but the best relay is good enough? It can cost you much more to settle for less than this CLARE RELAY.

Price is reasonable. Prices for Multi-element Mercury-wetted Contact Relays have recently been reduced. Delivery is quick—a few days to a few weeks, depending on assembly desired and size of order.

FOR COMPLETE INFORMATION on CLARE Mercury-wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address. C. P. CLARE & CO., 3101 Pratt Blvd., Chicago 45, Illinois. *In Canada:* C. P. CLARE & CO., 659 Bayview Avenue, Toronto 17. Cable address. CLARELAY.

Send for CLARE Sales Engineering Bulletins Nos. 120 and 122

CLARE RELAYS

FIRST in the industrial field

For more information circle **43** on inquiry card.

BIGGER THAN YOU THINK

Skinner solenoid valves are compact, tiny and lightweight.

But don't be misled — they'll easily outperform other valves that are much larger and heavier. Built to withstand high voltages and temperature extremes, Skinner valves provide leakproof, trouble-free operation through millions of cycles.

And being small, they are easily adaptable to your most compact equipment design. Call in a Skinner engineer on all your valve problems *first*. He can draw from over 100,000 variations . . . all of them *big in capacity, power and performance.*

Write for the new Skinner Solenoid Valve Catalog. On your letterhead, please.

SKINNER SOLENOID VALVES

SKINNER ELECTRIC VALVE DIVISION • SKINNER CHUCK COMPANY

THE CREST OF QUALITY

SKINNER ELECTRIC VALVES ®

116 Edgewood Avenue
New Britain, Conn.

WORLD-WIDE REPRESENTATION

For more information circle **44** on inquiry card.

INSTRUMENTS and AUTOMATION Events

November 1-2

Eleventh annual meeting of the Society for Applied Spectroscopy, Hotel New Yorker, N. Y.

November 1-2

5th Annual Instrumentation Conference to be held on the campus of the Louisiana Polytechnic Inst., School of Engineering, Ruston, La.

November 7-8

6th Symposium & Instrument Fair "Automatic Data Processing Systems". Sponsored by Phila. Section of ISA, Bellevue-Stratford Hotel, Philadelphia, Pa. For information write Horace Richter, Symposium Chairman, Fischer and Porter Co., 29 Bala Ave., Bala-Cynwyd, Pa.

November 7-10

SAMA Laboratory Apparatus and Optical Sections midyear meeting, The Homestead, Hot Springs, Va.

November 8-9

Electronic Business Systems Conference, Sheraton-Palace Hotel, San Francisco, Calif.

November 14-16

Optics and Microwaves Symposium at the Lisner Auditorium, George Washington Univ., Washington, D. C. Sponsored by the I.R.E. Professional Group on Antennas and Propagation, The George Washington Univ. and the Optical Society of America.

November 15

Joint Meeting "Automation in the Future" Metropolitan Section, American Society of Mechanical Engineers and New York State Society of Professional Engineers, at Consolidated Edison Co. Auditorium, New York, N. Y. For information write H. Johnson, c/o Consolidated Edison Co., 4 Irving Place, New York 3, N. Y.

November 26-30

Third International Automation Exposition, New York Trade Show Building, 500 8th Ave., New York, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

December 5-7

Second IRE Instrumentation Conference & Exhibit, Biltmore Hotel, Atlanta, Ga. Sponsored by Professional Group on Instrumentation and the Atlanta Section of the IRE. For information write M. David Prince, Engineering Experiment Station, Georgia Inst. of Technology, Atlanta, Ga.

December 6-8

The first Southwide Chemical Conference sponsored by the Southeastern and Southwestern Regions of the American Chemical Society with the cooperation of the Memphis Section of the Instrument Society of America, Memphis, Tenn. For information write Southwide Chemical Conference, 2899 Jackson Ave., Memphis 8, Tenn.

January 14-15, 1957

3rd National Symposium on Reliability and Quality Control in Electronics. Sponsored by IRE Professional Group on Reliability and Quality Control, and the American Society for Quality Control and RETMA, Hotel Statler, Washington, D. C.

January 23-25

Symposium on "Theoretical and Experimental Results in the Propagation and Radiation of Very-Low-Frequency Electromagnetic Waves (less than about 100 kc), "NBS Boulder Labs., Boulder, Colo.

February 26-28

1957 Western Joint Computer Conference, Statler Hotel, Los Angeles, Calif.

March 11-14

The IRE Professional Group on Nuclear Science is cooperating with the EJC Second Annual Nuclear Science and Engineering Congress in Philadelphia. For information write Dr. Sidney Krasik, Editor, IRE—PGNS Transactions, 5621 Wilkins Ave., Pittsburgh 17, Pa.

April 11-13

Nine Southwestern I.R.E. Conference and Electronics Show, Shamrock Hotel, Houston, Texas.

April 29-May 1

Eighth Annual Symposium on Spectroscopy, Hotel LaSalle, Chicago, Ill.

May 22-24

11th Annual Convention and Exposition of the American Society for Quality Control, Masonic Temple, Detroit, Mich.

BAKER
"know how" made it possible

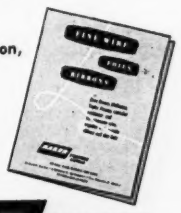
WIRE finer than .0004"

FOIL thinner than .0001"

RIBBON

Baker specializes in producing the fine wires, ribbons, strip and foils increasingly in demand for today's precise electronic instruments. Years of research and experimentation have developed the meticulous techniques and experience necessary for producing such wires in both ductile and non-ductile substances by the Wollaston, Taylor and extrusion methods.

For full information, send for our free booklet, "Fine Wire, Foils, Ribbons."



BAKER & COMPANY INC PRECIOUS METALS

113 ASTOR STREET, NEWARK 5, N. J.
NEW YORK • CHICAGO
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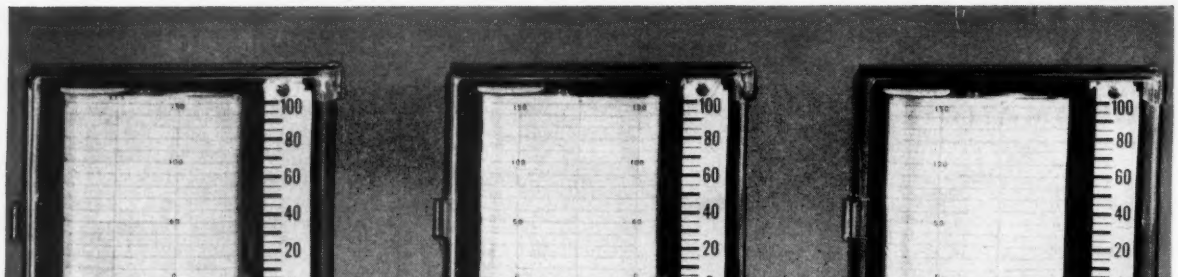
ENGELHARD INDUSTRIES

For more information circle 45 on inquiry card.



BRISTOL'S® NEW MINIATURE ELECTRONIC RECORDERS take only 5" x 5⅛" panel space—can be mounted on 6½" centers. Size and external appearance completely match Bristol's pneumatic Metagraphic® instruments. Sixty-three-foot chart provides 31-day record at 1" per hour. Wide variety of chart speeds available with easily changed gears.

New! Compact Dynamaster electronic instruments

Full plug-in versatility, true servo-driven null-balance operation, high sensitivity are features of Bristol's new Series 663 Dynamaster recorders, indicators.

Now, for the first time, you can get all the inherent accuracy, stability and versatility of Bristol's electronic potentiometer and bridge instruments in a line of instruments designed for graphic panels and centralized recording and indicating of large numbers of variables.

The new Bristol 663 Series Dynamaster Recorders feature the same basic mechanism as full-sized Dynamaster instruments, completely redesigned and repackaged to carry out the basic graphic panel idea. They provide compact, centralized electronic recording, indication, and control of temperature, pressure, vacuum, pH, humidity, liquid level, speed, mechanical motion, smoke density, voltage, current, power, resistance, strain or any other variable that can be translated into an electrical quantity. Check these design features:

1. True motor-driven null-balance operation. Bridge, potentiometer or differential transformer types available. No delicate galvanometer movement, no moving coil, no pivots employed. Unaffected by severe vibration. Plenty of torque for operating control mechanism, retransmitting slidewires, alarm contacts, etc. with full accuracy.

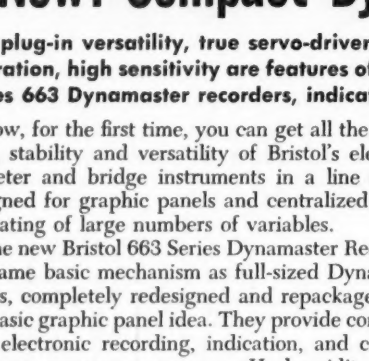
2. Reads directly from sensing elements such as thermocouples, resistance bulbs and other d-c output elements. No external converters with vacuum tubes and adjustments.

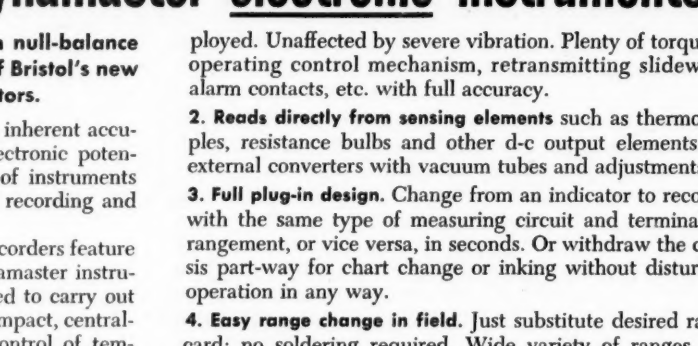
3. Full plug-in design. Change from an indicator to recorder with the same type of measuring circuit and terminal arrangement, or vice versa, in seconds. Or withdraw the chassis part-way for chart change or inking without disturbing operation in any way.

4. Easy range change in field. Just substitute desired range card; no soldering required. Wide variety of ranges and spans available.

5. Requires small panel space of only 5 x 5⅛ inches. Fifteen recorders or indicators mount in space required for two standard size electronic recording instruments.

Write today for complete data on the outstanding new Bristol Series 663 Dynamaster Instruments for your applications. The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut. 6.52





INDICATING RECEIVER (*left*) is interchangeable—in seconds—with recorder. Both indicators and recorders may be drawn to intermediate position for chart change, pen inking or inspection. Plug-in chassis (*above*) of resistance thermometer recorder. No external converter involving vacuum tubes and adjustments is required to operate Bristol's miniature Dynamaster instruments from resistance bulb thermometer or thermocouple.

Come and see us in Booth 301 at the 3rd International Automation Exposition

BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **46** on inquiry card.

SIGNIFICANCE

The function of the Steam Efficiency & Combustion Department, Jones & Laughlin Steel Corporation, Pittsburgh Works Division, includes the responsibility for the supply of proper fuels to the various steel melting and heating units, the efficient production and consumption of utilities, the selection, installation and maintenance of instruments and controls and equipment related thereto. Robert Lambert, Superintendent of the Steam Efficiency and Combustion Department, is the man in charge of these basic instrumentation functions.

His biography reveals the type of functions—and the type of man who can carry out the functions—of the instrument man in the iron and steel industry. You will enjoy meeting Bob Lambert, and we enjoy acknowledging his key position within the field of iron and steel instrumentation, and his many contributions to it. Typical activities at his plant are shown on pages 1998 and 1999.

ROBERT A. LAMBERT

Robert (Bob) A. Lambert was born in Pittsburgh, Pa. on July 3, 1907. After graduating from High School in 1925, and with no funds for formal college training, he started employment with Jones & Laughlin Steel Corporation as a Clerk in their Machine Shop. For eleven years he attended night classes in Mechanical Engineering at Carnegie Institute of Technology. Bob also took several post-graduate subjects such as Heat Engineering and higher mathematics.

In the years at night school, knowledge was being acquired in Heat Engineering under the much-appreciated guidance of Prof. Willibald Trinks. In 1937 Bob was transferred to the Combustion Department of the plant, then under the direction of Mr. L. T. Pearsall. In late 1937, in a reorganization with instrumentation and plant utilities, he became Assistant Combustion Engineer for the plant.

Most work at this time was concentrated in improving fuel practice and production in the open-hearth shops. At this time the byproducts of tar became sufficiently attractive for outside sales and the resulting residual tar pitch offered challenging problems as to its utility as a fuel. (Today such fuel is one of the most desirable for open-hearth firing.) In the early days of its use, difficulties were encountered in handling and open-hearth operators were none too favorable for its use. Many obstacles had to be overcome.

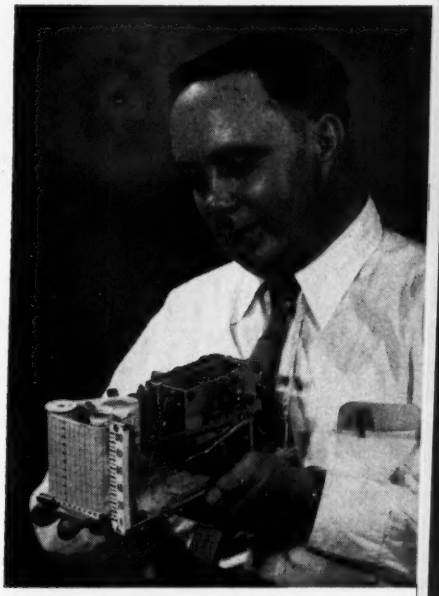
In 1938, his night-school classes over, he married and acquired himself thereby a 12-year-old son. He and his wife now have two grandchildren in addition to the son and daughter-in-law.

For five years Bob directed activities of the Combustion Division, which grew to encompass instrumentation and controls at all locations in the Pittsburgh Works Division. Open hearths, soaking pits, sheet and strip mills and bar mills over these years went thru a period of improved combustion control for the heating and melting furnaces, with attendant instrumentation.

In 1945 Bob was appointed Assistant Superintendent of the Steam Efficiency and Combustion Department. In this position he absorbed responsibilities for plant utility consumption and conservation, as well as plant fuel consumption and conservation; there was also included the fast-growing instrumentation within the heating and processing functions of the plant.

Under the Penn State Extension Services of the School of Mineral Industries and the Pittsburgh Public Schools, Bob taught night school classes in Fuels and Combustion at the South High School for three years, 1949 thru 1951. To develop his plant organization (which comprised most of the class attendance) he wrote a text that is applicable to the fuel problems in the steel industry. The text continues to be used as a reference and guide, although it has never been copyrighted.

In 1947 he was appointed to the position of Superintendent of the department, and still holds this position. In 1953-1954 he served as Conference Chairman of the Symposium on "Instrumentation For The Iron & Steel Industry," as well as Vice President of the Pittsburgh Section of the Instrument Society of America. In the year 1954-1955 he served as President of the Instrument Society of America, Pittsburgh Section, and is now a member of the Pittsburgh Section Executive Board.



Bob's second love—a control instrument.

Bob tells us, "I have been a subscriber to *Instruments* magazine since about 1942 and have been reading it since 1940. Personally, I have found it very helpful over the years in keeping acquainted with not only new products on the market, through advertising, but also in keeping abreast of instrument applications in the various industries. The magazine receives wide circulation in the department, although there are several members in the department who subscribe for their own copy. *Instruments and Automation* magazine, I believe, is the best in the field."

Bob is a licensed Professional Engineer of Pennsylvania, and his technical activities include membership in the Instrument Society of America, Engineers Society of Western Penna., Association of Iron & Steel Engineers, and the American Institute of Mining & Metallurgical Engineers. He has presented numerous papers relative to instrumentation and combustion as associated with the Steel Industry, which have been inserted in the records of their societies.

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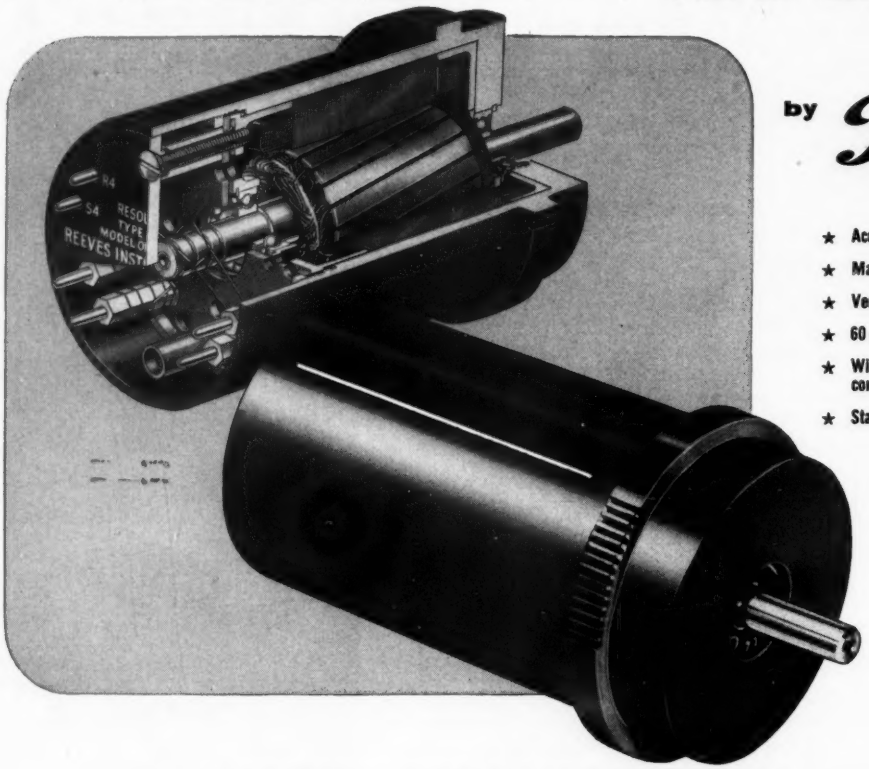

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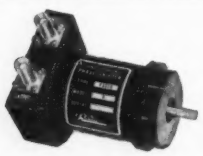

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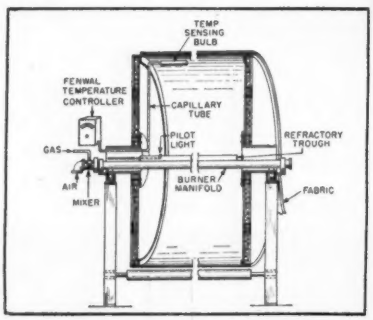
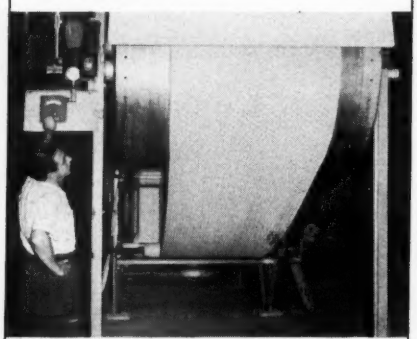
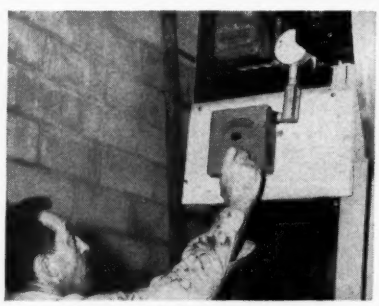


Drum temperature is controlled by a Fenwal Series 540 Indicating Temperature Controller. As shown in the diagram, this is connected by a capillary tube to the temperature-sensing bulb, located close to the interior surface of the drum. The trough and manifold are stationary along the axis of the drum. Flame is played along the surface of the trough by a series of jet nozzles, burning a mixture of air and natural or manufactured gas. To aid in preventing scorching the product, materials used for the drum and heater system are of lowest practical heat capacity. The drum surface is of 16-gauge steel, which assures a low heat content.

Also, the combustion air supply doubles as a coolant for the drum. The air stream is not tied in with the temperature control system and continues to flow after the gas is shut off. Thus, it quickly cools the heater trough and blows the heated air out of the drum. This, plus the low heat capacity of the drum surface, provides the required safeguard against scorching the product during sudden shut-downs.



PRECISE TEMPERATURE CONTROL, provided by a Fenwal Series 540 Temperature Indicating Controller (shown at left) is one of the advantages enabling this huge drying drum to set new records for efficiency. In one installation, three 60" diameter drums of this type are drying the same yardage as 20 previously used steam-dryers.



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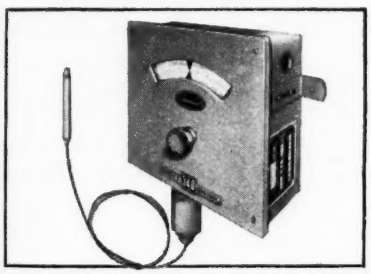
When the operator sets this Fenwal Series 540 Controller to the required processing temperature, he knows that temperature will be maintained — on the button! Heat input is controlled by the Fenwal unit, actuating a solenoid valve in the supply line. The gas, maintained at atmospheric pressure by a diaphragm regulator, is drawn into a proportioning mixer valve under negative pressure created by the air stream. The air supply, maintained at approximately one psi, reaches the mixer through a separate supply line.

With the Series 540 Control on guard over the heating system, the manufacturer of this advanced drying equipment states that the temperature of the drum surface is maintained within ± one-quarter per cent of the controller scale — outstanding performance for processing equipment of this type.

A Versatile Instrument



The Series 540 Controller is fully adjustable between 100°F and 700°F. Temperature differential is adjustable between 1% and 4% of scale temperature ranges by internal adjustment of pilot contacts. Uniform sensitivity and close accuracy throughout its range are characteristic, making it an ideal temperature indicating controller for kilns, ovens, liquid baths, baking ovens, packaging machinery and general industrial processing.

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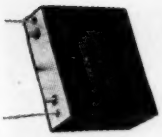

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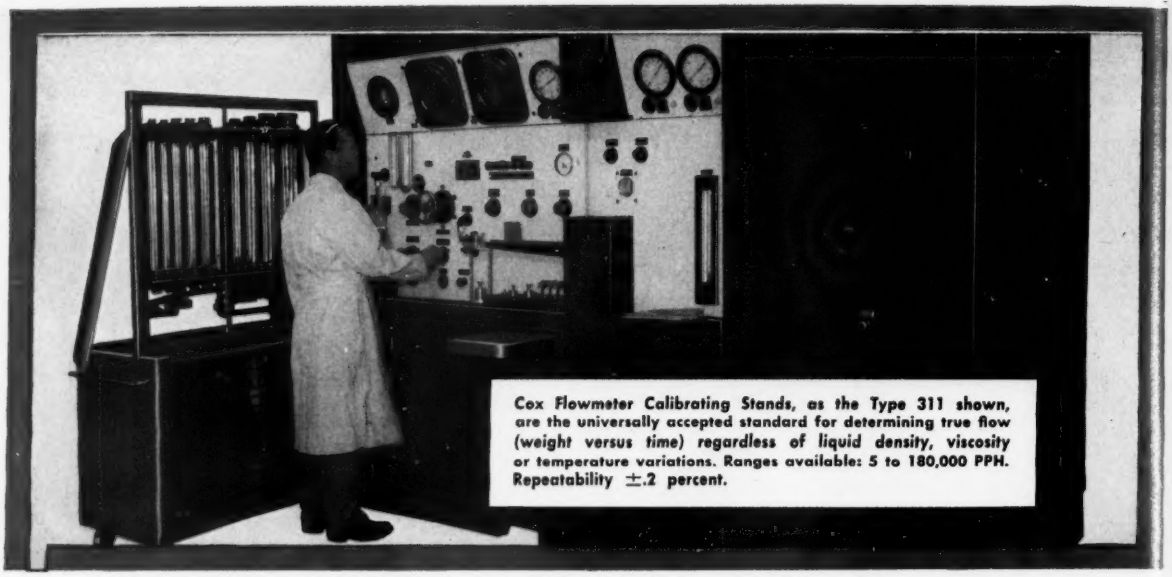

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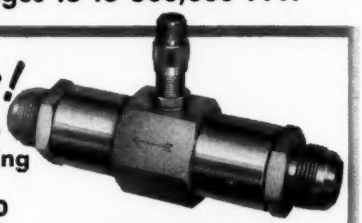

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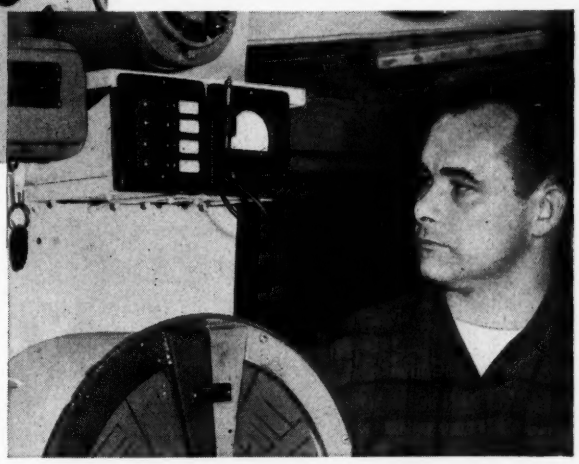

EDISON OMNIGUARD IMPROVES OPERATING EFFICIENCY

Whether you're seeking more production from electric power stations and plant equipment or greater safe speed from seagoing vessels, you will find Omniguard can help you get more efficiency from your present equipment.

Many operators are already using Omniguard, the unique temperature indicating and alarm system designed by Thomas A. Edison, Inc., as the best means of eliminating waste due to downtime, repairs and lost production.

Omniguard improves plant efficiency and lets you operate at peak capacity because it unfailingly reports when dangerous temperature conditions occur at one or more points. And does it at surprisingly low cost.

A modular system of monitoring one to an unlimited number of points simultaneously, Omniguard watches continuously. When a bearing starts heating up or a process becomes critically hot, it automatically gives a warning and/or shuts down the equipment before it is damaged.

The low cost unit is easy to install. It is non-electronic and simplifies installation and maintenance through the use of copper wiring between all components.

See for yourself. A personal demonstration can be arranged at your own plant. Take it apart. Analyze it. Find out how simply Omniguard improves operating efficiency. Just write!

Thomas A Edison

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

Thomas A. Edison

INCORPORATED

INSTRUMENT DIVISION • 24 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

For more information circle **54** on inquiry card.

RIGHT NOW...

Over 100 Epsco high speed reversible voltage-to-digital converters are in operation at over 25 separate commercial and military activities throughout the world.

No other voltage-to-digital conversion equipment presently available anywhere will approach the accuracy, conversion speed, reliability, long term stability, versatility and simplicity of operation of the Epsco Model B DATRAC® . . . regardless of price!

MODEL B DATRAC® FEATURES

ABSOLUTE ACCURACY: ±0.05% of full scale ±½ least significant digit.

CONVERSION SPEED: 44,444 independent V➔D conversions per second for an 11 bit binary code including sign.

RELIABILITY: Proven field service in excess of 5000 hours of continuous operation without maintenance.

LONG TERM STABILITY: Within one least significant digit for life of the equipment.

INPUT (V➔D): ±10 millivolts to ±1000 volts differential or single ended.

OUTPUT (V➔D): Binary or binary coded decimal.

SIMPLICITY OF OPERATION: No operator adjustments. Calibrated automatically to internal standard cell.

YOURS?

ASSOCIATED EQUIPMENT

- Electronic Multiplexers
- DC Amplifiers (Diff. Input, Low Level)
- Tape Buffer Storage
- Magnetic Core Buffer Storage
- Voltage Reference Source (Secondary Standard)
- MINIDATRAC: Subminiature Voltage-to-Digital Converter

See our DATRAC Exhibit at the:
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New York Trade Bldg; Room 416; Nov. 26-30; 1956

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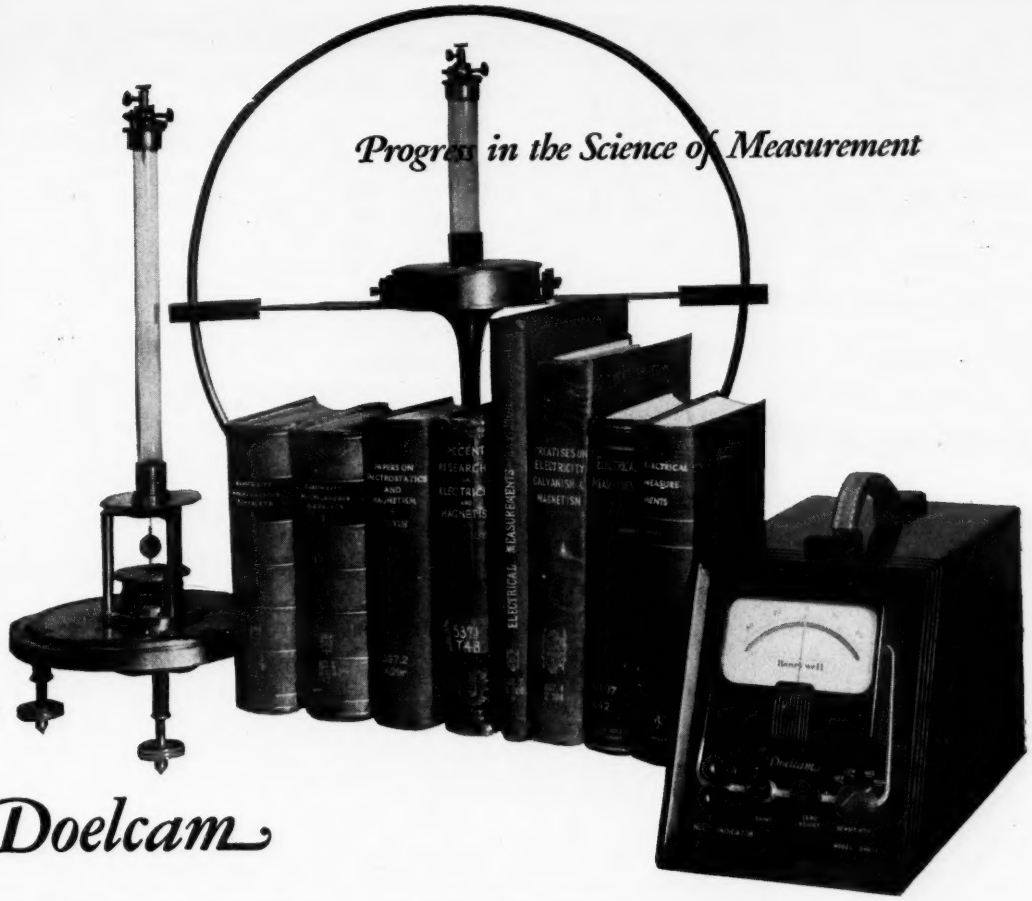
Progress in the Science of Measurement



Doelcam

MAGNETIK NULL INDICATOR

Today's Version of the D-C Galvanometer

The D-C Galvanometer was essential to the historic experiments in electricity conducted by men like Galvani, Ampère and Lord Kelvin. However, the dense stray fields of today's electrical world combined with the need for greater speed and accuracy in the laboratory and on the production line place a heavier burden on the present day galvanometer. The Doelcam Magnetik Null Indicator, Model 2HG-1, is today's most practical version of the D-C Galvanometer. Not only does it combine magnetic and electronic elements which make it insensitive to stray pickup; but it has 3 discreet ranges, a linear scale for deflection measurements, fast response and the ability to withstand overloads as high as 100,000 times full scale deflection.

Write for Bulletin NI-4

PERFORMANCE CHARACTERISTICS

ISOLATED INPUT: Input terminals are isolated from chassis and circuit ground.

HIGH SENSITIVITY: 2 Microvolts per division, 0.003 Microamperes per division.

HIGH CONVERTER FREQUENCY: 2500 cps carrier, insensitive to 60 or 120 cps pickup.

LOW NOISE LEVEL: Less than 2 Microvolts equivalent input.

EXCELLENT STABILITY: Zero drift less than 1 division per hour.

INDEPENDENT OF LINE VOLTAGE: No observable drift or change in sensitivity for line variations from 105 to 125 volts.

PROPORTIONAL DEFLECTIONS: Linearity over full scale range is 5%.

POLARITY SENSITIVE: Zero-center mirror-scale meter for polarity sensing measurements.

QUICK READING: Time constant of less than 1 second.

RUGGED: Not damaged by over-range of 45 volts d-c.

LOW MAINTENANCE: Only one vacuum tube. No moving parts except meter.

Doelcam
A DIVISION OF MINNEAPOLIS-HONEYWELL H HONEYWELL 1400 SOLDIERS FIELD ROAD BOSTON 35, MASSACHUSETTS

Instruments for Measurement and Control

Synchros • Gyros • Accelerometers • Amplifiers • Microsyns • Servo Motors

For more information circle **56** on inquiry card.

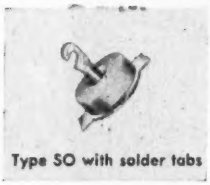
F.C.C. RADIATION INTERFERENCE LIMITS

Effective May 1, 1956 all radio receivers manufactured to operate in the range from 30 to 890 mc, including f-m and television receivers, shall not exceed the following field strength limits at 100 feet or more from the receiver:

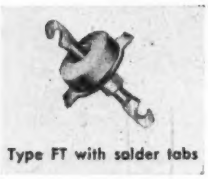
The total electromagnetic field at any point a distance of $\frac{157000}{f(kc)}$ ft. (equivalent to $\lambda/2\pi$) from the apparatus shall not exceed 15μv per meter. Radiation generated by oscillator sweep circuit must also be controlled.

COMPLY WITH F.C.C. REGULATIONS

Use Allen-Bradley Feed-thru and Stand-off Capacitors



Type SO with solder tabs



Type FT with solder tabs

Type FC Ferri-Cap filter

This new F.C.C. regulation on radiation interference imposes stringent requirements on radio and TV designers. Fortunately, Allen-Bradley Types FT and SO discoidal capacitors and Ferri-Cap filters completely satisfy these requirements.

Both Type FT (feed-thru) and Type SO (stand-off) can be supplied in standard nominal capacitance values from 5 mmf to 1,000 mmf. None of these Allen-Bradley units exhibits parallel resonance effects at frequencies of 1,000 megacycles or less.

Type FT feed-thru capacitors have soldering tabs or screw-thread mounting. Type SO stand-off capacitors are available with screw-thread mounting, self-tapping threads, or solder tabs.

The rugged construction reduces breakage during assembly line handling or from contact with carelessly handled soldering irons. The terminals are specially treated for easy soldering.

The Type FC Ferri-Cap feed-thru filter is a discoidal feed-thru capacitor in combination with ferrite material to provide internal impedances effectively in series with both ends of the feed-thru electrode of the capacitor. The Ferri-Cap filter is not susceptible to pickup, and does not require physical isolation with respect to the source of an undesired frequency.

Send for bulletin, today.

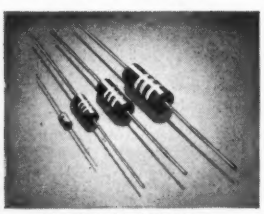
Type SO—screw mounting

Type SO—self tap. screw

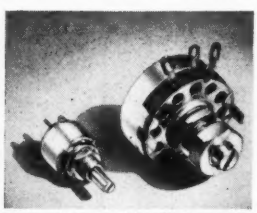
Type FT—screw mounting

Allen-Bradley Co., 140 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

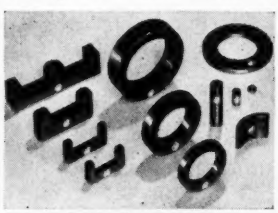
OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



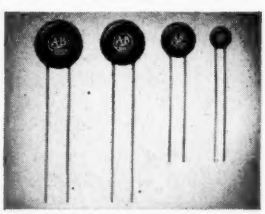
Fixed Molded Resistors
1/10, 1/2, 1 & 2 watt



Variable Molded Resistors
1/2 & 2 watt



Ferrite Components
High Efficiency

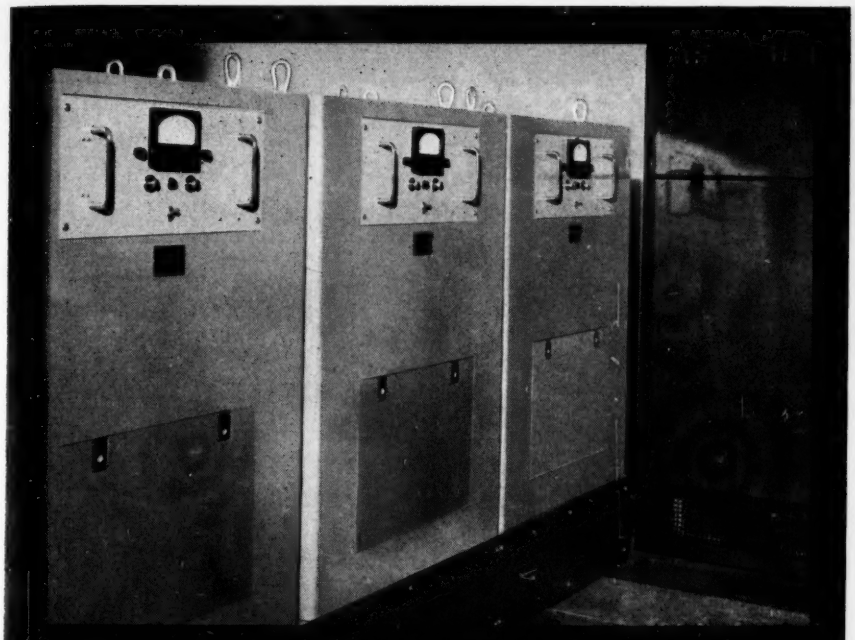


Ceramic Dielectric Capacitors
for by-pass and filtering

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

For more information circle 57 on inquiry card.



The STABILINE Automatic Voltage Regulator installation at station KTTV. Input: 215-245 volts, 50/60 cycles, 3 phase. Output: Individual Phase Control, 220 volts, 525 amps., 200 KVA.

Electronic equipment is designed to operate at specified voltages. There is no easier or better way to maintain constant voltage to electrically-operated equipment than with a STABILINE type EM. Available in standard models in capacities up to 100 KVA, a STABILINE type EM is highly efficient and has zero waveform distortion. To eliminate your Varying Voltage Troubles, install a STABILINE Automatic Voltage Regulator.

How Time Worth $1000 a Minute is Protected by a

STABILINE*

Automatic Voltage Regulator

Station KTTV, Mount Wilson, California, is owned by the Los Angeles Times.

At Television Transmitter Station KTTV a STABILINE Automatic Voltage Regulator has been in continuous operation, with no replacement of parts, for over two years. *By maintaining constant voltage to the transmitter, it has already paid for itself.* Expensive transmitter tubes require constant voltage for peak performance and long life.

At literally no cost, this STABILINE type EM helps to keep the station on the air by preventing lost time (worth nearly $1000 a minute) due to tube failure.

Be sure to visit SUPERIOR ELECTRIC'S Mobile Display when it is in your area

*Trademark Reg. U. S. Pat. Off.

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THE
SUPERIOR ELECTRIC
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710 MIDDLE STREET, BRISTOL, CONNECTICUT

Please send me your STABILINE Bulletin S157.

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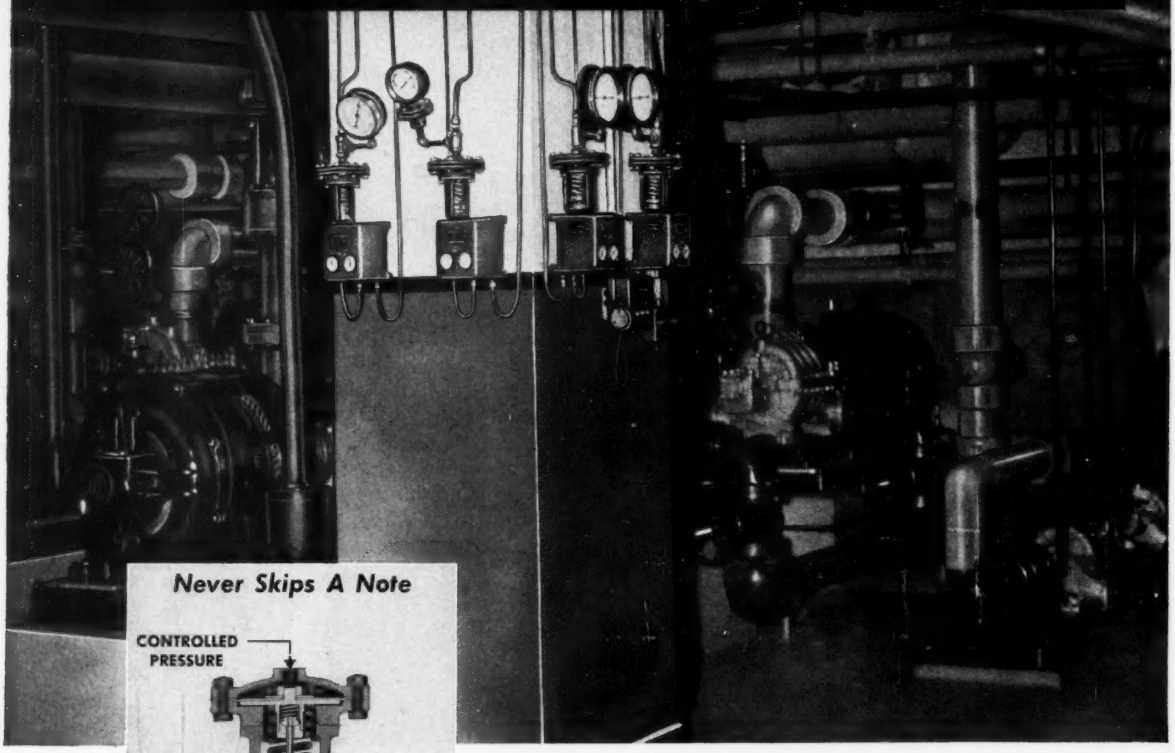
Company .....

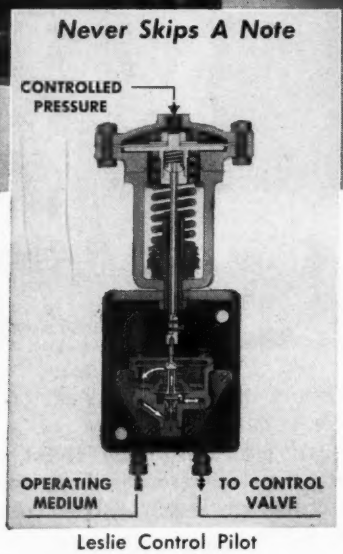
Address .....

City ..... *Zone* ..... *State* .....

For more information circle **58** on inquiry card.

Here's a Quartet of Control Pilots that Sings a Song of Savings





Leslie Control Pilot
Type PDA
Sectional View

NEVER A DISCORDANT NOTE from this quartet - - - they're always in tune - - - each unit doing its part to create 24-hour-a-day harmony. They save time — no personal attention or manual assistance required after they're set. Pressures stay at set point for top efficiency of process equipment in the line. Positive response of pilot and valve assures smooth throttling action within closely held limits.

The same smooth action and accurate control is provided even when extreme reductions are necessary (there are Leslie installations handling reduction of 2150 psi. to 5 psi. in one step!) Responds to pressure deviations as small as .025 psi., depending on pilot range.

For more information on controllers that save maintenance dollars, consult the nearest Leslie Engineer listed in your classified telephone directory under "Valves" or "Regulators". Use this help for economy in temperature and pressure regulation.

Bulletin 5303 sings the whole song. Send for it today.

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

For more information circle **59** on inquiry card.

NEW!
BK-3300, BK-3500, BK-3700—ultimate in precision made multichannel heads.
BK-1300, BK-1500 series—up to 25 interlaced channels per inch.
BK-1605 series—simple mounting and adjustment, ideal for drum computers.
BK-1501 series—compact, wafer-thin, permit individual adjustment.
BK-900, BK-1000, BK-1200 series—variety of types for single channel applications.

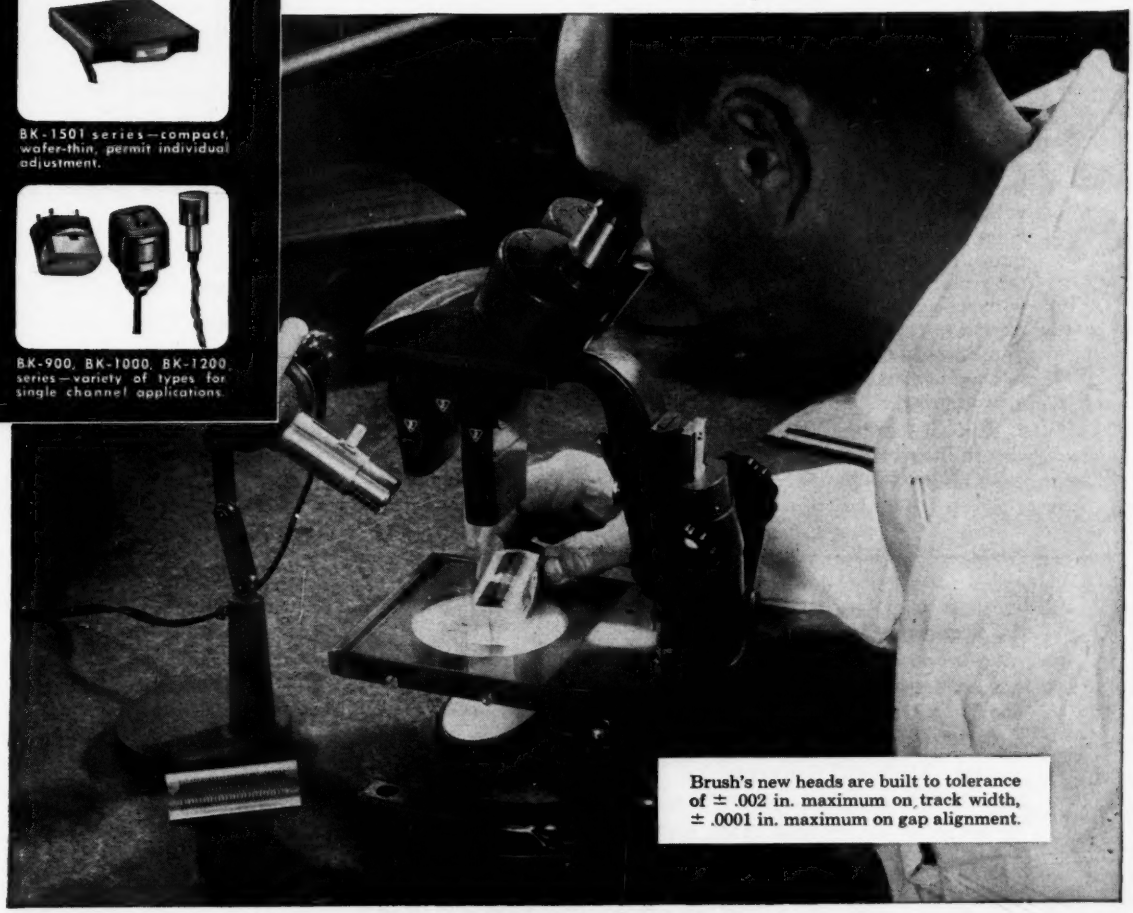
How Brush Magnetic Heads improve product performance

Microscopic inspection is a familiar tool in Brush's manufacturing of magnetic heads. Track width and gap alignment must be held to ten-thousandths; pole faces and tips must be lapped to a surface finish of better than 8 microinches.

This craftsmanship improves product performance. Precision gap alignment assures perfect time phase accuracy. Close tolerances permit greater pulse packing, increased storage capacity, uniform output and frequency response.

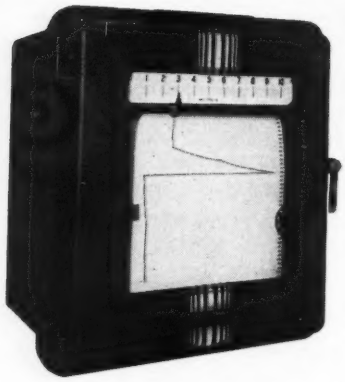
Get the facts on Brush's complete line of magnetic heads, including the new precision multichannel heads. Write Brush Electronics Company, Dept. A-10, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio
BRUSH 6 ELECTRONICS
DIVISION OF CLEVITE CORPORATION



Brush's new heads are built to tolerance of ± .002 in. maximum on track width, ± .0001 in. maximum on gap alignment.

For more information circle **60** on inquiry card.



SAVE
Data Plotting
TIME
With Speedomax® G Millivolt Recorders

• Measuring a physical or electrical quantity that can be converted into d-c millivolts? Then you can eliminate costly, time-consuming point-by-point plotting with one of L&N's complete line of Speedomax G Millivolt Recorders. You may require: stocked 0 to 10 millivolt recorders for general research and testing; recorders with special millivolt ranges for particular applications; logarithmic recorders for non-linear measurements; and microvolt or medium high impedance recorders for special uses.

These listed specifications may help you determine which millivolt recorder meets your requirements.

1. STANDARD MILLIVOLT RECORDERS

(Normally available for delivery from stock)

MEASURING CIRCUIT—D-c potentiometer.

ELECTRICAL RANGE—0 to 10 mv.

DEAD BAND—0.15% of range.

ACCURACY RATING—±0.3% of range.

SPAN STEP RESPONSE TIME RATING —1 or 2 seconds.

2. SPECIALIZED MILLIVOLT RECORDERS

MEASURING CIRCUIT—D-c potentiometer.

ELECTRICAL RANGE—Min. 0 to 1 mv; Max. 0 to 1,000 mv.

DEAD BAND—0.15% of electrical range, or 7 μv, whichever is larger.

ACCURACY RATING—±0.3% of scale span, or ±15 μv, whichever is larger.

SPAN STEP RESPONSE TIME RATING —1, 2, or 3 seconds nominal.

3. LOGARITHMIC MILLIVOLT RECORDERS

MEASURING CIRCUIT—D-c potentiometer.

ELECTRICAL RANGE — Min. starting point: 1 mv. Maximum full scale—1,000 mv.

LOGARITHMIC CALIBRATIONS—1, 2, or 3 cycles.

ACCURACY RATING—For 1 and 2 cycle logarithmic scale calibrations: ±0.7% x number of cycles. For linear scale calibrations (density, etc.): ±0.3% of scale span.

4. MEDIUM-HIGH IMPEDANCE RECORDER

MEASURING CIRCUIT—D-c potentiometer.

ELECTRICAL SPAN—Minimum span of 10 mv at resistances up to 100,000 Ω, 20 mv at 1 megohm.

INPUT IMPEDANCE—2 megohms.

EXTERNAL CIRCUIT RESISTANCE—As high as 1 megohm.

DEAD BAND—0.2% of electrical span.

ACCURACY RATING—±0.3% of electrical span.

5. MICROVOLT RECORDER

MEASURING CIRCUIT—D-c potentiometer.

ELECTRICAL SPAN—400 μv min., 2 mv max.

DEAD BAND—0.2% of electrical span.

ACCURACY RATING—±0.5% of electrical span including allowance for dead band and thermals.

For more information on this versatile line of Speedomax Millivolt Recorders, ask our nearest Sales Office for Data Sheet E-ND46(6) or write to Leeds & Northrup Company, 4955 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP
instruments automatic controls • furnaces

For more information circle **61** on inquiry card.

INSTRUMENTS and AUTOMATION

Editorial

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—***M. H. Aronson,*** Editor

A New Concept

STATISTICS on modern giant trade shows such as the IRE or ISA or WESCON reveal a growth that is gratifying to our field of instrumentation—the orders of magnitude are now visitors by the scores of thousands, and exhibits and papers by the hundreds. But this growth has brought its problems.

It is now physically impossible for a man to do much more than glance at most of the exhibits, or listen to more than a few papers. In fact, one often precludes the other. The show visitor must allot his time to a small percentage of exhibits, listen to a few papers, or talk to a small number of exhibitors.

Still other problems have arisen. Hundreds of the top men responsible for the activities of society-sponsored shows spend much of their time in committee activities; they see even less of the show than the non-society visitor. The exhibitor is told that 40,000 men attended the show in which he exhibited. The number might as well be 400,000—he and his staff could only talk briefly to a few hundred men. And the now vast areas of floor space prevent the average visitor from even seeing the name of the product, let alone discussing its application. The educational efficiency of the present setup is becoming smaller as the simultaneously held exhibits and conferences become larger in number and size.

For these reasons the conversion of a trade show into a giant classroom in the hours when the show is not open to the public represents a fundamentally new concept in trade exhibition and mass education, a concept that could eliminate the inherent and growing educational weaknesses in the modern trade show as it now exists. At the Third International Automation Exposition, which will be held Nov. 26-30 (Automation Week) in New York City, more than 300 90-minute technical classes will be held in front of the operating equipments on exhibit. Lecturers will demonstrate how available commercial equipments solve the problems of plant, factory and office automation —not theoretically or generally; but practically and actually, using operating equipments. Thousands of registrants will receive a basic education on analog computers, digital computers, servomechanisms, data handlers, process control, office automatic, machine tools, and automatic gaging, cleaning, and fabricating. This new concept may reverse the trend to lowered educational efficiency in trade shows, and merits the close attention of our entire industry.

ISA Show Highlights

THE 1956 ISA Conference and Exhibit was a huge success by every criterion—attendance (over 35,000) exhibits (nearly 400), papers (about 130) and financial ($285,000 gross take). Perhaps the only detectable weakness was in the quality of some of the papers presented, and in the attendance at some of the technical sessions and clinic classes.

It is of interest to note the power of propaganda and excitement; there was more interest in the IGY sessions where the instrumentation is relatively exotic than in the clinic classes where good practical application and maintenance material was to be had. The data-handling workshop was an outstanding success, further evidence that this field has at last arrived at the acceptance stage (the primary evidence being the orders for systems now on the books of the suppliers).

Many show viewers, looking for exciting disclosures, expressed dissatisfaction. This attitude was caused in part by the mass of conventional instrumentation, tending somewhat to overshadow the many novel instruments disclosed, and in part by the fact that all instruments evolve through three basic stages—(1) the "disclosure" stage, accompanied by revolutionary claims and high excitement, (2) the "proving" stage, accompanied by usually years of eliminating bugs, solving application problems, and adding up huge figures in debit columns, and (3) the "acceptance" stage, exemplified by backlogs of orders. Perhaps the big news of this show is that data-handling equipments have arrived at stage 3—acceptance. This year, all exhibited data-handling systems worked, and orders were entered on backlog only by most exhibitors. Data handling has arrived.

In contrast, computers are only now going through the horrible stage 2—horrible no less to the engineers behind the development than to management. Perhaps this is why few computers were exhibited, compared to previous years. However, we predict a complete break-through in the computer field—particularly the analog computer in process applications—within the next few years.

In this respect two papers should be mentioned—(1) *Analog Simulation of a Chemical Reactor* by Bagde, Franks, and James of DuPont, Wilmington, and (2) *Application of the Analog Computer to Measurement of Process Dynamics* by Cowley, of Shell Development, Emeryville, ASME Paper 56-IRD-20.

Continued on page 1966

EDITORIAL—CONTINUED

Another theme of the show was the building-block approach to control systems. Bailey had this as the theme of their exhibit, and many process control firms showed their unitized elements. Illinois Testing Labs introduced a line of "Servoblox" units—amplifiers, bridges, digital readouts, recorders, etc. Dozens of firms offered unitized subassemblies.

It is fashionable to note the progress of transistors. Manning, Maxwell & Moore has transistorized the Microsen line of process controllers, making it the first transistorized line of general-purpose electronic process controllers. Daystrom has transistorized some beautifully miniature servos and receivers and Offner has transistorized the new Type 542 Dynograph—but some electronic instrument manufacturers seem held back from transistorization by several reasons, one of which is lack of acceptance by servicemen in the plant (a factor of high importance and one often ignored in technical discussions).

Also evident as a trend is the manner in which the larger firms are emerging as integrated companies either via purchase of several smaller companies in associated fields or by development of comprehensive lines of associated instruments. Large plant constructors are already finding it economic to turn over all instrument problems in a given field, such as all the analytical problems and analytical instrumentation in a proposed plant, to an instrument company specializing in this field. For example, all the analytical instrumentation for a new ammonia plant was recently subcontracted to the Beckman Instrument Company, which used the instrumentation of other manufacturers as well as its own, as required. The Beckman display itself (and a special press conference) was designed to show the integrated operations of their various divisions; other exhibits, particularly the Fischer & Porter, Consolidated Electrodynamics, Minneapolis-Honeywell, General Electric and Daystrom used the same theme—the ability of the integrated company to bring a veritable powerhouse of equipment and experienced engineering brains to bear on any given problem in the field of specialty.

Your editors will try to summarize a few of the many show "firsts," particularly those which might be overlooked by the sensation seekers. We begin with apologies to the hundreds of products that will not be mentioned—no show report could include every new development exhibited. (This is why most editors confine their reports to glamorous pictures and innocuous comments on meetings and personalities.) But the new products are the real show news.

1. Norden-Ketay (Instruments & Systems Division) revealed a basic new Bourdon pressure-gage movement, the "Bandrive," which uses a simple Neg'ator strip to replace the conventional segment gear, pinion, and hairspring. Advantage: up to 20 times the life of the standard movement in rough, vibrating service.

2. Edge-lighted plastic digital readouts were everywhere—but watch the new Nixie and Pixie numerical indicators disclosed by Burroughs Electronic Tube Div. These cold-cathode-type readouts have less parallax difficulty. The Berkeley in-line readout is readable from a side angle because it uses "grain-of-wheat" lamps arranged in patterns behind slots, whence no "stacking" of numerals and no blurring at all.

3. There was a lot of valve news—the brand new electrohydraulic operator of Mason-Neilan that uses a differential transformer in the feedback loop; the new Type C Vernier Valvactor positioner of Foxboro; the new electro-pneumatic positioner of Moore Products that uses a coil in a magnetic field to operate a pilot; the new all-electric valve actuator of Conoflow that requires 4 ma dc signal to stroke the valve (principle is a force-balanced differential transformer); the new Super 70 Series valves of Black, Syvalls & Bryson that use float rings instead of flange-type bolting.

4. The monitoring and data-reduction news included the pinboard programmer for the Beckman data control system; an operating MilliSADIC of CEC in their mobile van (special orchids to the CEC "classes" that demonstrated the operation in 20-minute sessions in the CEC Van—see pic); a 120-point scanner-logger of Minneapolis-Honeywell; the E101 digital computer of Burroughs, whose big feature is pinboard programming that is easy to learn; new digital printers of Victor Adding Machine that print 3 lines/sec, 10 characters/line; a new APR automatic production recording system of IBM for handling production-type data (where was the RAMAC?); the new 50VS (operational visual sequence) monitoring technique of Panellit in which the *first* off-normal variable flashes red; the Metrotype data logger with a plug board for setting up the variables and scales.

5. There were a lot of exciting recording developments. Bristol unveiled a miniature Dynamaster recorder with a 3″ strip chart. We acclaimed the Century Electrograph recorder and the Acton carbon-coated acetate-film recorders when they were disclosed at the IRE Show; Offner disclosed its transistorized Type 542 Dynograph and made a first disclosure of a Dynograph recorder with either rectilinear, curvilinear, heat-sensitive, electric or ink recording all in one recorder(and when you need one type of recording technique you need it badly; if only for a short time); Sanborn revealed a new automatic programmer for a computer that prints the zero references, inserts calibrating voltage into each channel, switches to computer input, runs off a given length of paper, and returns to zero (this can be a real test automation device); Potter Instrument exhibited the new 3-ms start-stop digital tape handler; Varian introduced the new G-11 strip-chart null-balance recorder that is small, portable, and rack or panel mountable (feature is economy at the expense of slight reduction in speed and accuracy).

6. Fielden revealed new pneumatic-electric-pneumatic conversion units that convert process variables to 3-15 ma dc (transmitter) and reconvert to 3-15 psig pneumatic signal (receiver) without vacuum tubes (transmitter principle is bellows, beam, coil in magnet field, and carbon-pile pressure-sensitive electrical resistance). Fielden has been pushing for a 3-15 ma standard electrical signal to correspond to the 3-15-psig pneumatic standard; sounds logical at a time when it appears that hybrid electric-pneumatic systems are optimum for many applications (as brought out in Paper 56-28-1). This important "PEP" conversion system permits electrical transmission techniques to be used with any pneumatic control system.

7. SIE introduced a flow computer Type DRF that

Amid the hundreds of displays were two mobile units—the Consolidated Electrodynamics van shown here and the Benson-Lehner van.

Show visitors hear how *Instruments & Automation* covers the field of instrumentation with more than 2000 pages of copy, 2000 new instrument reviews, and 2000 literature reviews each year.

extracts the square root of a pressure head by electronically taking the log of the pressure differential (with a log network), then dividing the electrical signal in half. Any other power can be taken easily by this technique. The antilog is found simply by a log network in a feedback circuit. Comparison of this flow computer with the Librascope flow computer shows the difference between an electronic and a mechanical approach to the same problem.

8. Norwood Controls reavealed the Deltaswitch Hg-jet commutator, featuring 120 contacts, rotor speeds of 6000 rpm, and interruptable current of 75 ma. Also disclosed was a "Microsyn" rotor-stator-type pickup with 12 poles on the rotor, 24 on the stator; 0-10-v ac output is developed with rotational motion of only 2½° of rotor. Pressure instruments were shown with this pickup.

9. Hundreds of other items deserve mention, including the *Decker* line of instruments based on the T-42 transducer (the sensation of an earlier show); the *Dekoron* Super Poly-Cor plastic tube in a plastic shield with life up to 3.5 times that of copper in a metal sheath; Servotherm heat detectors (infrared) of *Servo. Corp. of* America with response of ¼ second and sensitivity of 0.05°C; the Barber-Colman Wheelco MMP magnetic modulator for converting d-c signals into a-c for amplification, and which acts also as an adder for the error signal; the *Technical Products Co.* TP-625 Frequency Analyzer that analyzes frequency and amplitude by Fourier technique within frequency range of 2 to 25,000 cps (user can look at any 2 cps); *The Edin Co.* Spectrum Analyzer with 24 selectable bands by plug-in filters (analysis is performed over successive 10-second periods); the *B&F Instruments* automatic bridge balance and calibrating unit featuring series as well as shunt calibration; the *Intercontinental Dynamics Corp.* Sigmatron random noise generator, designed for simulation via random-frequency signals; the *Precision Scientific* automatic distillation unit for petroleum and solvents that plots temperature vs. volume with capacity of 100 ml; the new *Mine Safety* "Thermatron" that uses both thermal conduction and thermal convection to increase the selectivity of gas analysis; the *Baird-Atomic* Turbistat that monitors turbidity (by photoelectricity) in fluids and suspensions to 0.05 ppm, and also a lab gas analyzer said to be "first negative-filter non-dispersive analyzer available for lab use" that can analyze all gases except the diatomics; the new Merchen pneumatic scale feeder of *Wallace & Tiernan* featuring a pneumatically controlled gate; a new automatic film processor of *Hathaway;* the new d/p transmitter and valve manifold Type ESV of *Republic,* consisting of two line shutoff valves and two equalizing valves with a vent plug, designed to minimize the problems in manifolding differential-pressure instruments; the complete line of graphic panel instruments by *Bristol;* the 3000 Series control valves of *Hammel-Dahl,* featuring calibrated hysteresis test of every valve; the direct-reading digital-readout flowmeters of *Fischer & Porter;* the frequency meters and monitors of *Biddle,* using reeds and featuring accuracy to 0.1%; *Bendix-Pacific's* digital calendar-clock . . . . . **MHA**

Some Conference and Show "Firsts"

M. F. BEHAR

OF prime historical importance and scientific value was Dr. Raymond Jonnard's disclosure via a Conference paper of a new type of interferometer which gives science and industry one more decimal place—eight instead of seven. And Jonnard in the nineteen-thirties and forties had done much to refine interferometry from six to seven decimals! His monumental achievement received no publicity outside the Conference program, but it will be included in all future books on optics because it combines several "firsts," among them the first application since 1815 (yes, 1815, not 1915) of the simple apparatus devised by Arago to demonstrate his then-daring concepts of velocity, periodicity, and difference between optical and geometrical path-lengths.

"EVA" deserves to head my list of exhibited "firsts" because it represents the first commercial embodiment of what had only been a scientific curiosity. "EVA" is the popular name given by Baird Associates to their apparatus for measuring the temperature of an object at a dis-

EDITORIAL—CONTINUED

tance by the rate at which the radiant flux from that object evaporates an oil film and thereby alters the film's color fringes.

Next "first" is likewise in the field of temperature measurement but its makers, though proud of its newness and usefulness, evidently do not—or did not—consider it a "first" because it is such a humdrum little thing in comparison with the other new products unveiled by the General Electric Co. Nevertheless I hail as an important "first" G-E's concentric thermocouple. To be sure, concentricity alone is not new: Foxboro's well-known Pyod dates back to World War One. But the Pyod is a rigid rod-like structure; and the shaping and welding of its junction is a factory job. The new concentric thermocouple is so small that it was exhibited by G-E under a magnifying glass. It comprises a 0.008″ O.D. Alumel wire in a 0.032″ O.D. Chromel tube of 0.003″ wall thickness. This couple is sheathed in a protecting tube of stainless steel or other suitable material whose O.D is 0.050″. Aluminum oxide powder is used as insulation. The sheathed assembly can be bent to a 1/16″ radius without damage. Outstanding novelty: the user can cut off the lengths he needs and make his own junctions in a few seconds—by arc welding in an inert atmosphere.

Of about forty new analytical instruments shown by about a dozen companies, the outstanding "first" was Varian Associates' nuclear magnetic resonance spectrometer. Although NMR spectrometers have been built to order by instrument companies since 1954, this is the first dual-purpose NMRS, combining a wide-line type and a high-resolution type into one instrument.

Back in 1931 there appeared the first commercial instruments utilizing capacitance variation for *continuous* measurement of moisture content, of density, of thickness of paper or rubber sheets, etc. Today they are made by some twenty or thirty companies—but to my astonishment there were two real "firsts": (1) Hygrotest Inc. showed a new combination of oscillating the capacitance-type probe across the paper or pulp web at speeds up to 135 fpm, plus automatic compensation for basis-weight, temperature, and other sources of error. These new automatic compensation methods have been embodied in a food industry installation (Spencer Kellogg) where, for the first time in history, the moisture content of a large stream of cereal product (850 tons a day) is controlled to 0.15% of the desired value which usually is 11% by weight. (2) A water-in-hydrocarbons recorder made by Foxboro whose "Dynalog" is a capacitance-balance instrument. The problem of *continuously* measuring water in crudes, etc., by means of a capacitance-variation probe was thought to be insoluble, but Shell Oil inventors devised the correct probe with the correct compensatory means, and Foxboro now sells the complete system.

The big "first" of aviation was the nearest to the ideal pocket-size automatic self-balancing potentiometer or bridge—about a fifth of the weight of the industrial control-board "miniatures." These subminiatures were developed by D. K. Warner's Flight Test instrument designers at North American Aviation and were unveiled in New York by Autonetics Div. of NAA. It usually takes them less than a fifth of a second to come to balance. Each indicator is usually connected in sequence to a number of temperature, pressure, and other primary elements.

An entirely new mode of automatic temperature control is utilized in the Leeds & Northrup "auctioneering control assembly" comprising (1) a 24-point recorder acting as a monitor, (2) a search discriminator unit, and (3) an automatic controller. The "auctioneering" behavior of this system consists in scanning all points and controlling on the hottest.

Wescon Hi Lights

MILO D. PUGH

WESTERN ELECTRONIC SHOW and CONVENTION (popularly called Wescon) was held in Los Angeles, August 21 to 24, and was attended by more than 25,000 engineers, technicians and business men.

Wescon is jointly sponsored by the San Francisco and Los Angeles sections of the Institute of Radio Engineers, representing the Seventh Region and the West Coast Electronic Manufacturers Association. Although a regional show, it has taken on the character of a national show—over 80% of the exhibitors are manufacturers with headquarters east of the Rockies.

More than 700 firms exhibited their products at the Pan Pacific Auditorium. Some 49 technical programs were held covering a wide range of subjects from Medical Electronics, Control Systems, and Automation to Earth Satellites and Computers. More than 200 papers were presented.

The new products exhibited included many new types of components, test instruments, and computers, some of which are briefly covered in the following:

Fairchild Electrotechnics Div. displayed a Resistance Bridge Indicator unit for multi-channel automatic digital

Optical Coating Laboratories, Inc. introduced a new "Dichroic Coating" which reflects one portion of the spectrum and transmits another.

G. M. Giannini & Co. displayed a new pressure scanner, a high-temperature potentiometer (200° C.) a new a-c output rate gyro, and a servo bridge computer.

Servo Corp. of America offered an infrared radiation pyrometer for measurement and control of fast-moving objects; also a thermistor heat detector useful for operations too fast, too inaccessible, too hot or too rigid for temperature indication by other means.

Librascope, Inc. showed a pressure-compensating totalizing flow computer which simplifies computations in orifice measurement of fluids. This firm also had in operation their general-purpose computer and computer components as well as an X-Y plotter and recorder and accessories.

Texas Instruments, Inc. showed the world's largest man-made crystals of germanium and silicon (see illustration); also a full line of transistors, rectifiers, and other semiconductor elements.

Hycon Mfg. Co. presented a new compact transistor pow-

er supply called the Hycon-verter, designed to replace vibrators, inverters, and dynamotors; also a new 5-inch oscilloscope and a working model of r-f scatter transmission systems.

Weston Electrical Instrument Corp. displayed the "Vamistor," a new type resistor whose resistance is not appreciably affected by temperature change (in this resistor, a metal film in spiral form is permanently bonded to the inside of a glazed vitreous porcelain tube); also a new modulating device for temperature measurement of aircraft engines.

Bourns Laboratories exhibited their new line of humidity-proof and high-temperature "Trimpots."

B-J Electronics displayed their Vibrotron Digital gages and associated digital systems.

Helipot Corp. offered "hot off the griddle" their new 5200 series potentiometer as well as improved models of their 10-turn series 7700 and 15-turn series 9500; also the "Yo-Yo" potentiometer actuated by a cord or fine wire to the pulley of the pot—when the cord is pulled, the pot shaft rotates.

Allen B. DuMont Laboratories, Inc. showed a multiplier phototube for subterraneous exploration; also (shown for the first time) the new type 352 Oscillograph-record camera.

Century Electronics & Instruments, Inc. showed the new electrophotographic recording oscillograph with 24 channels.

Burroughs Corp. showed a model of the SAGE defense system with a new electrographic high-speed 5000-character-per-second printing device (characters are formed by electrostatic charges on a surface coated paper); also a magnetic core tester for tape-wound bobbin cores.

Texas Instruments' Wescon Feature.

William Miller Instruments offered a new d-c amplifier stabilized for drift and gain over a frequency range from 0 to 30,000 cps.

Non-Linear Systems exhibited an analog-to-digital converter which counts at a speed of 400 steps per second; also a line of digital ohmmeters and digital voltmeters.

DEAR D.R.*:

Another month has rolled around in what seems like 30 minutes rather than days. We had a chance to talk to many of you at the ISA Show—but not nearly enough; that is what prompted our editorial "A New Concept" on page 1965.

For quite a while we have been bringing you masses of wonderful (in the educational sense) material on analog and digital computing techniques. By now every one of you should be an expert on simulation and digital automation! This month we call your attention to a powerful discussion in the *Simulation Council Newsletter* on Combined Analog and Digital Computation. Here you will learn how both techniques are being put to work on the same problem, combining the speed of the analog with the accuracy of the digital. You are right up at the frontier of modern instrumentation in this discussion.

Joe Hussey also tells you this month how the analog computer can be used not only to analyze your system (which we have been pleading with you to do) but also to control it. This is in the article "Process Control and the Analog Computer," beginning on page 2000.

That's an interesting figure—2000. It means that you now have received more than 2,000 pages of material so far this year in *I&A*—in fact this October issue ends on page 2134, *not counting* the 300-page Part II Handbook and Index. Are you getting your $4 worth? And wait 'till you see what's coming!

Martin, Frank and Harry tell you this month (in No. 12 of the Digital Automation series, pages 1979-1984) how to set up control programs for processes with digital techniques. The matrices may look complicated—but by now you know how simple they really are; and the trunking matrix permits even greater reduction in the number of diodes. There's a matrix in your future—so don't miss this article. It's important.

Chet Beard concludes his coverage of valve positioners this month with a discussion of positioners for cylinder operators. The growing emphasis on cylinder actuators, single-seated valves, high-speed operation, and precise control all make positioners a No.-1 subject today; and you have had No. 1 coverage of them last month and this month.

There is still a lot of show news. Hope you like our report on the ISA and Wescon shows (pages 1965-1969)—and keep your eye on the Third International Automation Exposition, New York, Nov. 26-30. This attempt to turn an entire trade show into a giant classroom has many important implications to our industry—and to all industry in general. This is your individual opportunity to get some practical application instruction on many of our editorial themes—analog computation, digital data handling and computation, servomechanisms, process control, automatic manufacturing, etc.

Hope this finds you well and happy this month. See you at the Automation Show next month.

Cordially,
Milt and the Editors

*Dear Reader

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Classes will be held in conjunction with the Third International Automation Exposition, New York, N. Y., Nov. 26-30, 1956. In the mornings you attend classes; in the afternoons you monitor this giant exhibit which occupies all five floors of the New York Trade Show Building.

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THE BRISTOL COMPANY
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FISCHER & PORTER COMPANY
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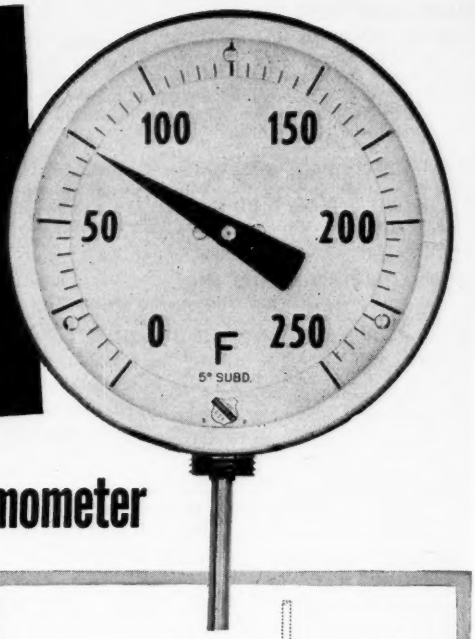

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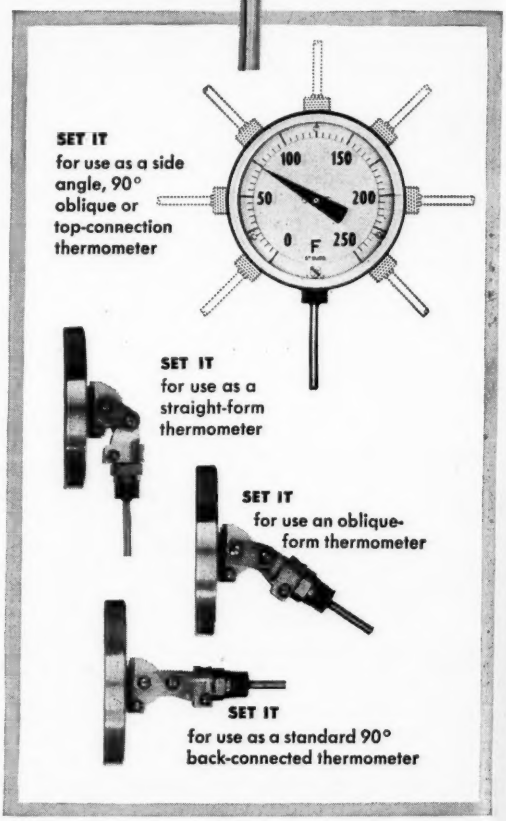
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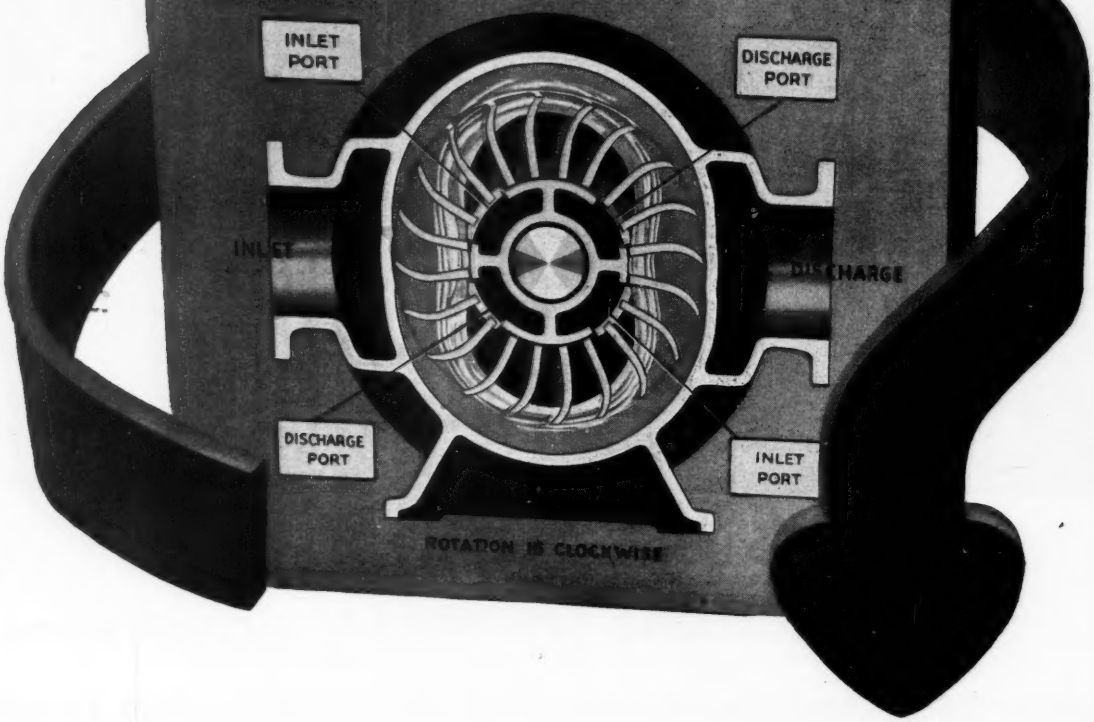

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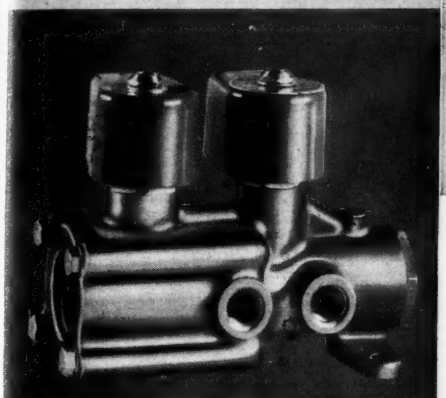
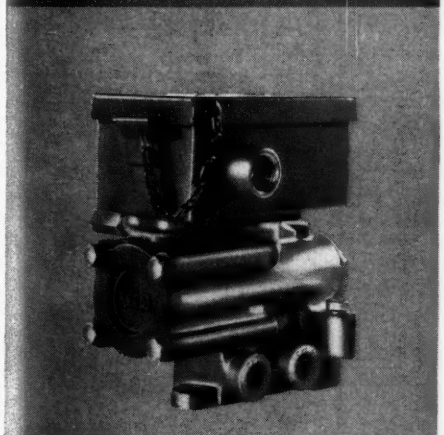


Dual Solenoid: operates when either solenoid is energized; will not return until opposite solenoid is energized. Solenoids may be energized continuously or momentarily.



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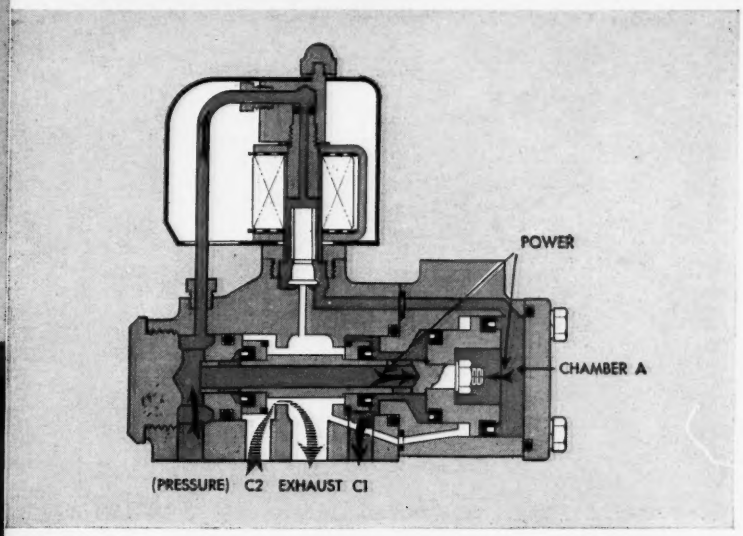

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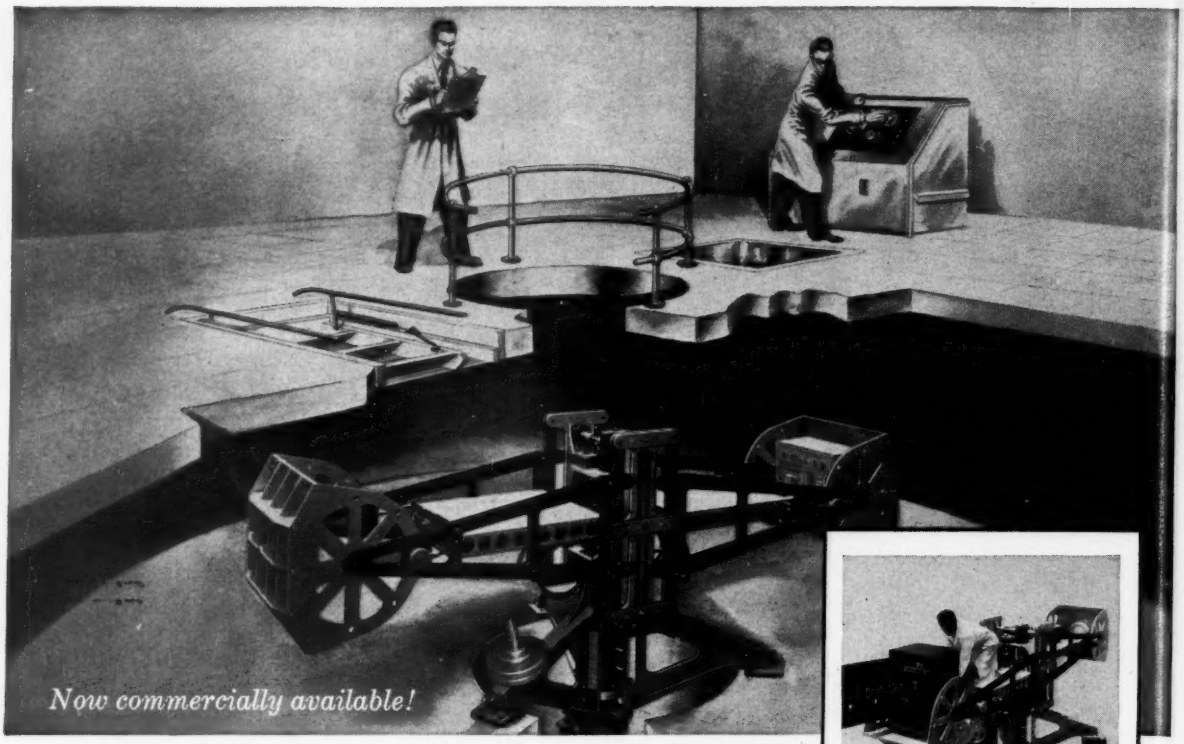


New Genisco Centrifuge subjects two 300 lb. assemblies to 100 G's

Genisco's Model E185 G-Accelerator, capable of subjecting complete electronic and mechanical systems to G-loadings that simulate actual flight operation, incorporates numerous unique features that simplify operation, reduce servicing, and allow precision testing to meet the most stringent military specifications.

The absence of belts, pulleys, and gears permits smooth and vibration-free rotation of the 12-foot rotor so that delicate inertial guidance systems can be tested. The machine is rugged enough, however, to accommodate proof-load testing.

Operation is unusually simple. Operator responsibility has been minimized, with many operational functions being accomplished automatically. Numerous built-in safety features afford maximum protection to both personnel and the machine.

These design features, plus wide flexibility in the use of the machine, reduce maintenance requirements, and together with low initial cost make the Model E the best large centrifuge currently on the market. Complete specifications will be sent on request.

SMOOTH, CONSTANT ROTATION—Hydraulic drive system permits a clean, compact design. Problems of backlash, gear noise, and frequent lubrication are eliminated. Wow and drift during a one-minute period are less than 0.5% of the operating rate at any speed.

SIMPLE SPEED CONTROL—A single handwheel, located on a remote-control console, determines boom speed. Speed adjustments are made quickly without reading complicated scales or dials.

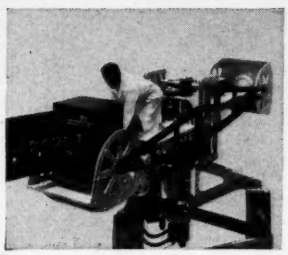
AUTOMATIC DYNAMIC BALANCING—The boom seeks a dynamically balanced condition automatically. Manual computation to determine centers-of-gravity is eliminated.

BOOM SPEED EASILY MEASURED—Coarse speed indication is accomplished by a specially-calibrated tachometer, accurate to within 1% of actual speed. Precision measurements are provided by a pulser/electronic counter, on a 4-decade digital display.

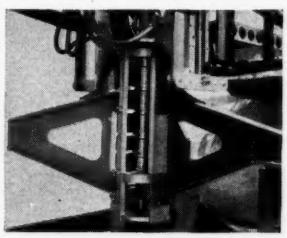
REDUCED HORSEPOWER REQUIREMENTS—By utilizing aircraft design techniques and enclosing the structure in an aerodynamically clean compartment, horsepower requirements are reduced to 15 h.p. for a 100-G machine.

BUILT-IN SAFETY FEATURES—Eight safety interlocks, including three which are key-operated, prevent the machine from being started inadvertently. Removal of any key renders the machine inoperable, permitting the operator to make adjustments to the test object in absolute safety.

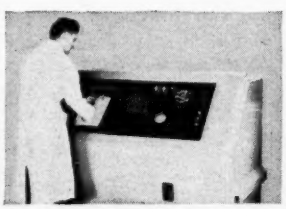
CLOSED-CIRCUIT TELEVISION SYSTEM—A closed-circuit industrial television system, incorporating a camera, control unit and remote video monitor, can be provided as auxiliary equipment for the optical surveillance of test objects under acceleration.



MOUNTING PLATFORMS LOCK IN FIVE POSITIONS—The mounting platforms can be locked in the horizontal, 45°, 90°, 135°, and 180° positions, permitting test objects to be subjected to G-loadings through several axes without demounting.



SLIP RING SYSTEM—A total of 48 slip rings are provided as standard equipment in a configuration of 24 unshielded leads rated at 14 amperes maximum, and 24 shielded leads rated at 1 ampere. Brush holders have been removed in the above photograph.



REMOTELY OPERATED—A control console permits complete operation of the rotor assembly from a remote position. All operating controls and switches are located on the console panel.

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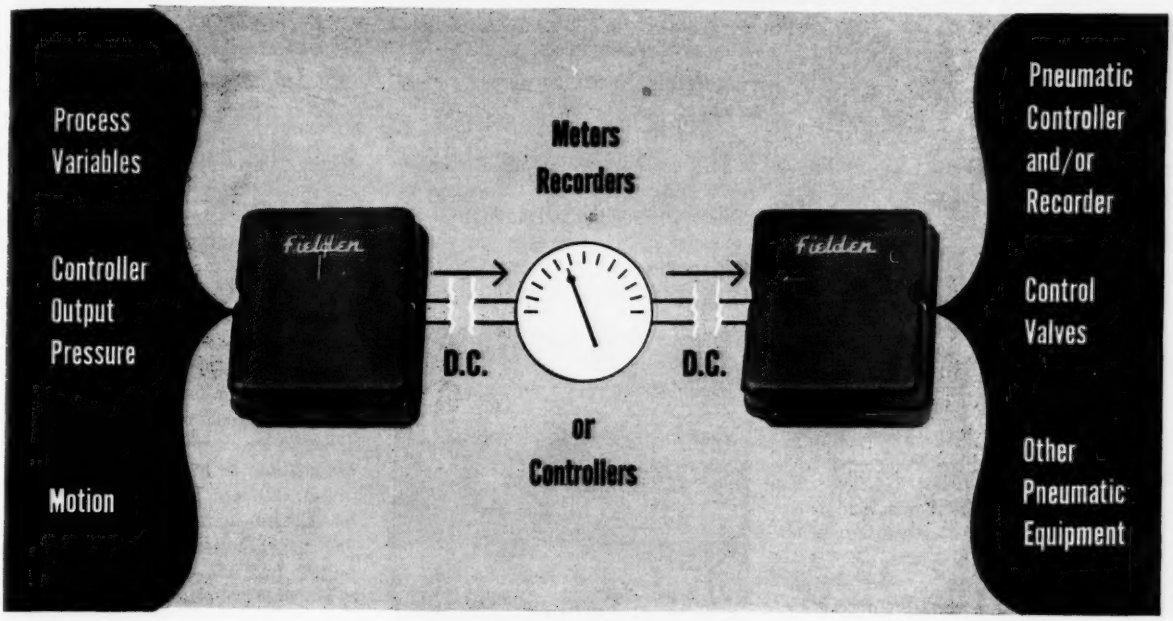
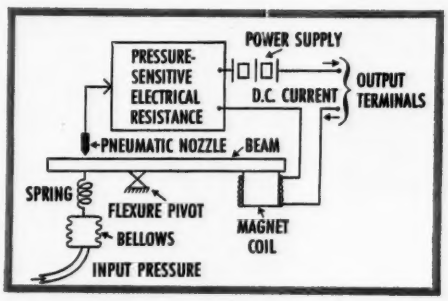
New from Fielden—A System to Convert and Transmit Any Process Variable Electrically





Used with a pneumatic or mechanical transducer, the P-E-P System balances forces on a flexure mounted beam. Beam unbalance is detected by a pneumatic nozzle causing variation on a pressure-sensitive electrical resistance. This changes a rebalancing direct current which is then transmitted.

The operation of the P-E-P receiver is similar to the transmitter shown except that the transmitted current is received by a magnet coil, the pressure-sensitive resistance is replaced with a pneumatic pilot valve, and the output pressure is fed back to the bellows to rebalance the beam.

Write for additional details on the P-E-P Transmission System and on Packaged Scanners for monitoring process variables.

P-E-P is new from Fielden . . . the Pneumatic-Electric-Pneumatic Transmission System that converts all process variables to a direct current for simple transmission, and reconverts to a pneumatic output . . . all without vacuum tubes or complex circuitry. Its simple design assures low installed cost, dependable, fail-safe performance, instantaneous response, low maintenance. Its versatility permits remote measurement, indication, recording and control.

Fielden Modern Instrumentation at its best, the P-E-P Transmission System is different because it uses pneumatics as a simple power amplifier and error detector instead of using an electronic circuit. It takes the output of any suitable pneumatic or mechanical transducer and converts it into a DC signal of 3-15 milliamperes for transmission electrically. The receiver converts this DC signal to pneumatic pressure of 3-15 PSI for actuating control valves or other pneumatic equipment.

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- **Slanting Rain: "Shadows" created on a surface by its irregularities and discontinuities magnified 200,000 times through electron microscopy.**

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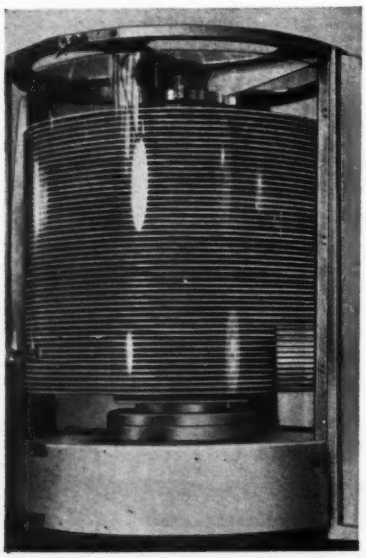
Random Access Memory Accounting

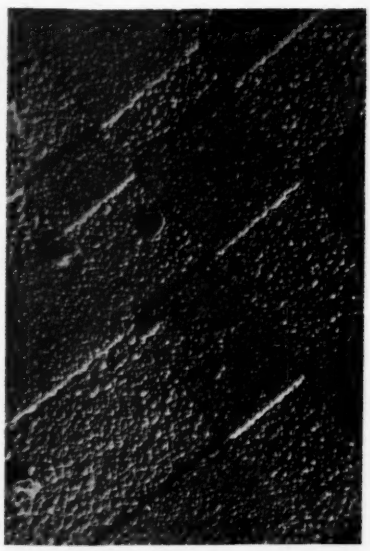
RAMAC, IBM's newest data processing system, needed a unique memory storage system. Ordinary methods of memory storage—magnetic tape, drums, ferrite cores—couldn't store enough "bits" of information. It took a research team of ours, with Trigg Noyes and Wes Dickinson as key men at IBM's San Jose Research Labs, to find the answer. The heart of this new idea: magnetic disks, played and replayed like the records in coin-operated music machines!

Here's how it works: Information is stored, magnetically, on fifty disks which rotate at 1200 rpm. These disks are mounted so as to rotate about a vertical axis, with a spacing of three tenths of an inch between disks. This spacing permits two magnetic heads to be positioned to any one of the 100 concentric tracks which are available on each side of each disk. Each track contains 500 alphanumeric characters. Total storage capacity: 5,000,000 characters. The two recording heads are mounted in a pair of arms which are moved, by a feed-back control system, in a radial direction to straddle a selected disk.



RAMAC's memory

This new system promises memory storage possibilities never before accomplished. If you'd like to read more about the engineering design of this magnetic-disk, random access memory system, write for IBM Bulletin No. 400.



Blown-up shadows

Slanting Rain

All of us have stood on a tall building on a cloudy day and looked down at the street—pretty difficult to judge relative heights of objects that far below, wasn't it? But during late afternoon on a sunny day the lengths of shadows made your estimates of height as easy as apple pie. The 100,000-volt Electron Microscope at our Poughkeepsie Research Laboratory allows us to study the topography of surfaces in just the same way. Instead of relying upon the obstruction of light by objects on a surface, we cause them to obstruct a slanting rain of metal vapor. Where the rain falls on a thin collodion coating previously put on the surface, the transmissibility of electrons through the coating is altered when it is put into the Electron Microscope; the "shadows" can be magnified and recorded on photographic film. A photographic enlargement made from the film can result in magnification of 200,000 times, thus making it possible to clearly observe an object less than one ten-millionth of an inch in diameter; or, this dash, —, magnified to the extent that it would appear to be about ¼ mile long. This magnification is about 200 times greater than practical in light microscopy, primarily because of the greater resolution possible in the EM, due to the short effective wave length of electrons.

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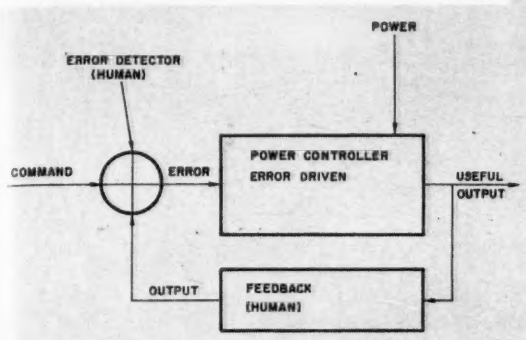


Fig. 12-1. Basic elements in a closed-loop system.

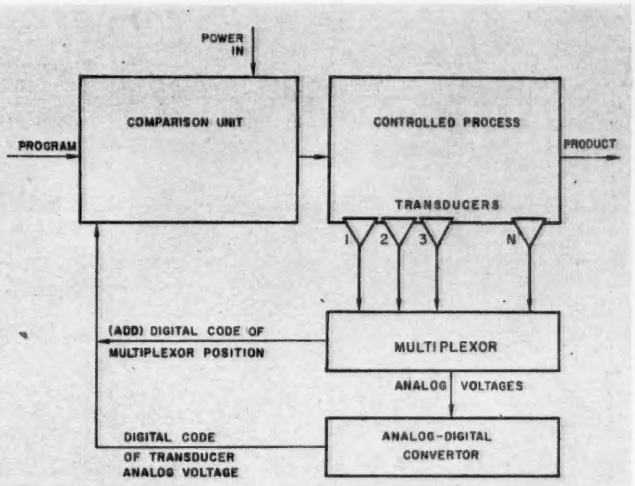


Fig. 12-2. Digital process-control system.

Digital Process Control

The analog-to-digital converter, trunking matrix, and comparison matrix can be used to control valves at any desired level of a variable, and at any desired accuracy. Here are the principles, techniques, and design considerations for complete digital process control.

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN
Rocketdyne Div.,
North American Aviation, Inc.

ALL closed-loop automatic-control systems have several basic elements in common, as shown in Fig. 12-1. These include (1) a command or desired control point or desired control program, (2) an error detector or comparison device to detect any deviation of the controlled variable from the desired control point, and (3) a controller that makes some correction to the process in order to return it to the control point. Process control systems also use large numbers of sensing devices which indicate the state of the process in terms of each variable. That is to say, if the engineer decides that his chemical process is to take place at certain temperatures and pressures and at certain times, instruments must be provided to sense the pressures, temperatures, and time. These are the variables for the process in question.

In many processes the basic operations of comparison and correction can be performed efficiently by a human operator; hence the "error detector" and "feedback" units in Fig. 9-1 can be human or automatic. However, there are processes which are completed in thousandths of a second, or which require complicated corrective actions, or which require continuous and infallible control. Here a human operator is incapable of acting, let alone thinking and concentrating continuously about what he must do. An automatic system must be used in such cases to perform the same functions as the human operator (error detection and feedback) but to surpass the human operator in reliability, speed of response, and logical decision-making.

In summary, any process automation system must provide control for an arbitrary process involving several steps for completion, must provide for a preset program and its alternates, and must compare the state of the process with the program and take the necessary steps to complete the program. Further, this should be done at speeds in excess of human capabilities. Can this be done digitally at the present time? The answer is yes. Fig. 9-2 shows such a digital process-control system.

Converting

Most existing instruments that sense process variables provide a voltage which is an analog of the variable

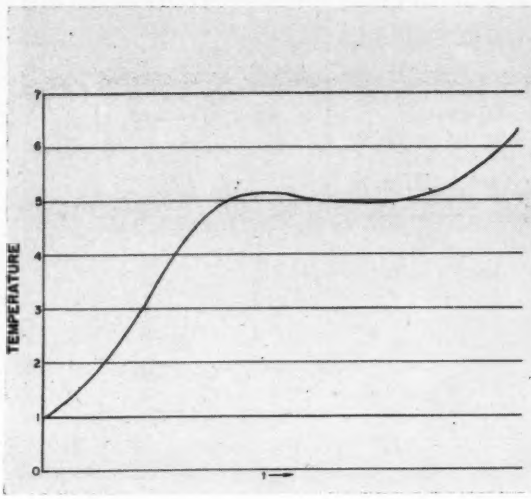


Fig. 12-3. Most commercial pickups provide an analog-type signal, such as this curve of temperature vs time.

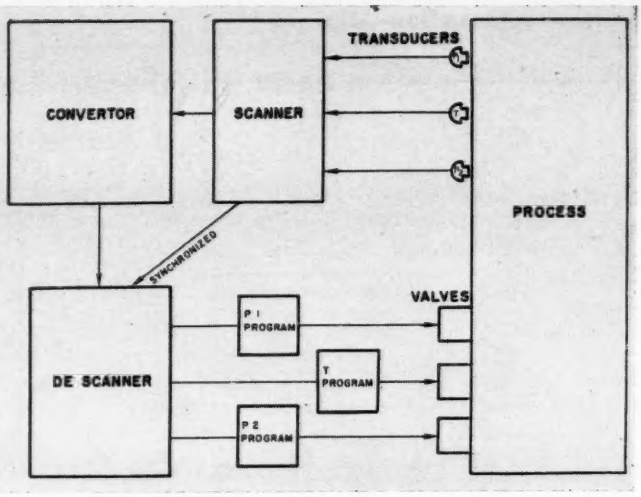


Fig 12-4. Process in which the temperature at one point and the pressure at two points are used to control three valves.

being sensed—for example, Fig. 12-3 shows a curve of temperature vs time which is produced by an instrument whose output is a voltage which is continuously proportional to the temperature being sensed. Here the voltage is an electric analog of the temperature.

The first step in using this electric analog signal is to convert it to digital form. The continuous electric analog signal is read at fixed intervals and a series of pulses is generated, each of which represents the voltage (and thus the temperature) at the instant of conversion.

The pulses generated are usually a binary code. For example, in Fig. 12-3 we have a signal which varies over a range of 0-7. Suppose we read this in binary code, allowing readings to the nearest unit (eight distinct readings). The binary numbers for the numbers 0 to 7 are:

Number	Binary Code
0	001
1	000
2	010
3	011
4	100
5	101
6	110
7	111

and if we let "1" represent a pulse and "0" no pulse, we can represent the voltage at any particular instant by a series of pulses. This can be done at any rate—at 1 or 100,000 readings every second.

A human operator can read a point on an analog curve in about two seconds. Using a conversion rate of 100,000 readings per second, we can perform the operation electronically 200,000 times as fast as a human operator. These pulses then represent the state of the process every 1/100,000 second, and the electronic reading can be made with an accuracy of 0.1%—which exceeds the accuracy of the human eye in reading an analog signal from a graph.

Multiplexing

Another unit used in the digital system of Fig. 12-2 is the *scanner*, or *multiplexer*. In a complex process we might wish to know the pressure at several places, the temperature at several other places, and other variables as well. Say we wish to know 100 different pressures and temperatures. The scanner permits these analog readings to be converted to digital code by a single analog-digital converter. The scanner works like a rotary switch, allowing first the signal from one point to pass to the converter while shutting off all others, then the next, then the third, and so on.

If we have a converter which converts to digits in 1/100,000 second, and if we have 100 information channels, we can convert each channel—with one converter—every 100/100,000 second; which is once every millisecond. This is still far faster than human capabilities. For 1 millisecond, each channel is allowed to reach the converter and is then shut off. Then the next channel is allowed to reach the converter. These scanners are essentially diode matrix circuits, as described previously. Being all-electronic, they can operate at the required high speed without difficulty. This link in the automation process of Fig. 12-2 precedes the converter.

Note that these two units are both in the feedback loop of the system. They take the state of the process readings at many points, convert them to numbers (pulses), and prepare them for the *command and comparison unit* of the system. It is clear that if we can use these numbers automatically in some method of comparison, we can control the process by giving a corrective command, automatically. These control and comparison circuits are based on logical diode networks similar to those described in Chapter 3.

Control

Suppose that these three units—converter, scanner, and comparison-command matrix—are combined to control a system automatically. As an example we will automatically control a simple chemical process in which we need to control the temperature at one point and the

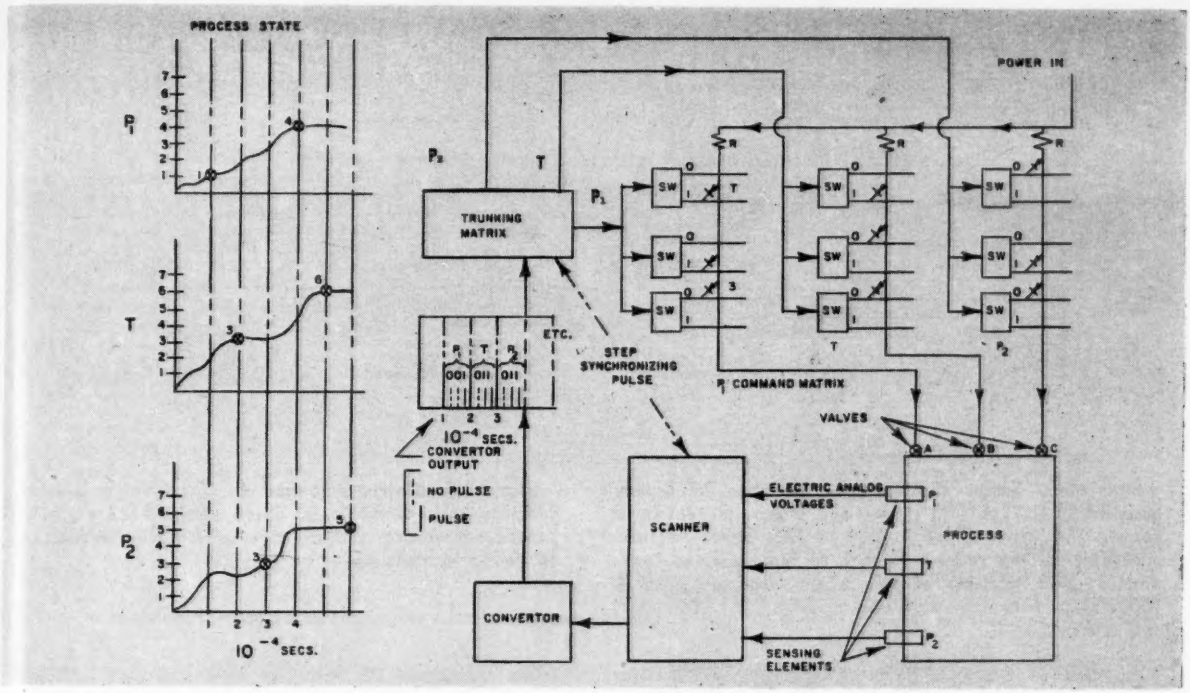


Fig. 12-5. Elements in the digitally controlled chemical process. Each variable is multiplexed in the scanner, then converted in the converter, then sent by the trunking matrix to the proper comparison matrix, each of which controls one valve.

pressure at two points, as shown in Fig. 12-4. The first step is to set up a *program* based on our knowledge of the process being controlled. Let us set down the program as follows:

Measurement	Value Required	Action to Perform
Pressure 1	4 units	Open valve A
Temperature	6 units	Open valve B
Pressure 2	5 units	Open valve C

The pressure and temperature pickups and the valves we wish to open and close are shown in Fig. 12-4. These three instruments are connected to the scanner, which reads each pickup at a rate of, say, 100,000 readings per second. Thus each of the channels is read every 3/100,000 second. At time 1, the scanner reads pressure 1 and, as shown in Fig. 12-5, the converter puts out a series of pulses which in binary code reads 001, the pressure of 1 unit as indicated on the analog trace of the instrument reading (P1) at time 1 at the left of Fig. 12-5.

These P1 pulses now pass through a de-scanner, which is another scanner that changes in step with the multiplexing scanner and channels the pulses to the correct comparison network. It can be thought of as a second rotary switch, mechanically linked to the first one, which directs the pulses into different lines. In this case the pulses are directed into the P1 comparison network set up for the pressure desired at the process point where pressure 1 is being read. In Fig. 12-5 this de-scanner is marked "trunking matrix" because such a matrix is an efficient de-scanner, as will be explained later in this discussion.

According to the program, we have set up the P1 comparison-command network so that the vertical line will be active only at 4 units—in other words, only when the switches are in position 100 (with the least significant bit at top). As the pulses directed to the SW units (switches or flip-flops) to represent number 1 are 001, the current does not pass down the line, but is short-circuited through the first and third diodes and the relay at the bottom of the line (not shown) does not close. As this relay controls the valve marked A, the valve will not open. The diodes are so placed in this vertical matrix line that the power signal will reach the bottom of the line only when the pulses 100 (representing 4) are sent by the trunking matrix to the three switches or flip flops marked SW.

The scanner now steps to the temperature-measuring instrument and, simultaneously, the de-scanner steps to the temperature-comparison network. This delivers the signal T1 to the center comparison network. The signal from the temperature-measuring device now reaches the converter and is turned into pulses 011, representing the number 3, as shown at time 2 on the temperature curve. The set of 011 pulses passes through the de-scanner to the temperature controlling network. In this network we have set the diodes so that the valve B is opened only when the number 6 (110) reaches the center comparison network. As the 011 pulses fed through represent the number 3, no current reaches the bottom of the line and value B does not open.

The scanner steps now to read pressure instrument 2, and the trunking matrix feeds the P2 signals to the P2 comparison network (at the upper right in Fig. 12-5). At time 3, the pressure from instrument 2 reads 3 units. As this comparison network has the diodes arranged to open valve C only at 5 units of pressure (101), again nothing happens.

The scanner now steps and reads pressure 1 again (3/100,000 second after the first reading was made).

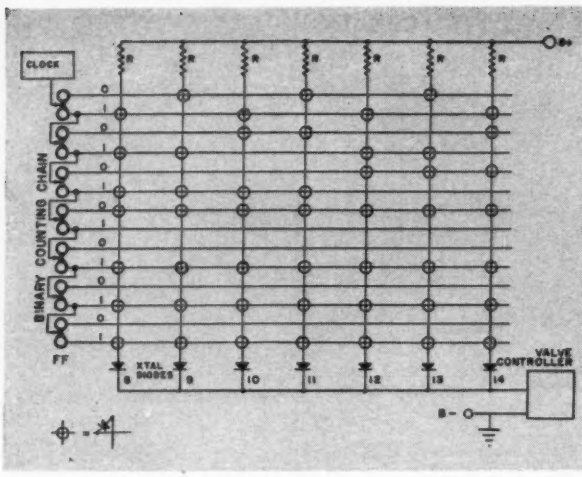


Fig. 12-6. Seven flip-flops or switches in binary counting chain (at left) permit this seven-line matrix to control the valve within 1 part in 128. Seven vertical lines have diodes placed at each of the encircled junctions so that the line at left is activated on input 8 (0001000); next line activates on input 9 (0001001), and so forth.

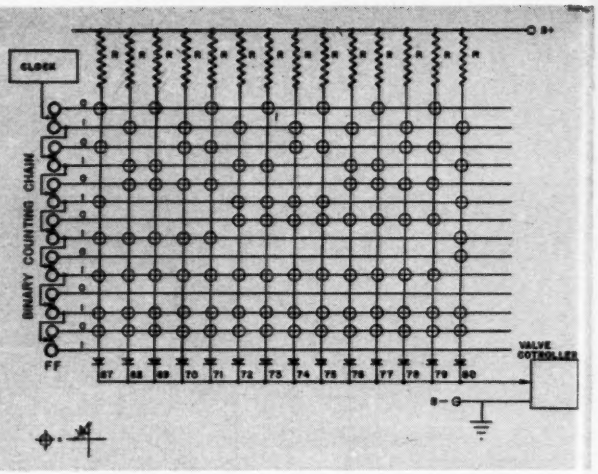


Fig. 12-7. Matrix arranged to open valve between pressure units of 67 to 80. Here again, each encircled junction represents a diode bypass from the vertical line to the horizontal line.

The de-scanning matrix also steps back to the P1 comparison network. Now the pressure read (at time 4) is seen to be 4 units (100). This time the pulses sent to the SW units in the diode network are the correct binary number; the SW units now disconnect all the diodes, permitting the current to reach the bottom of the line and open valve A. The first step has now been completed.

The scanner and de-scanner step once more, reading the temperature at time 5. The temperature now reads 6 (110) and the pulses 110 from the converter set the temperature-comparison-network switches to 6 in binary code. Now the current is no longer bypassed through any diode in this line, reaching the bottom of the line and opening valve B. On the last step of scanner and de-scanner, pressure 2 is read and the number 5 (101) is set in the switches. This allows the current to open valve C The control of this process has been completed.

Although this is a simple process, programs and alternate programs of great complexity can be constructed with little extensive modification of principle or equipment. In fact the complexity of the program is limited only by the engineer's ability to consider all possible routes he would like the program to take.

Quantitative Limits

The system described was based on a go or no-go basis. That is, a unique value was assigned to the pressure, temperature and other variables at which valve action was to take place.

Suppose that a valve is required to remain open between the values of 8 and 14 psig, within 1%. Here the operating limits become a band of values. In fact, separate operational bands could be desired so that the valve is open in the range from 8 to 14 psig and also in the range of 67 to 80 psig. Let us see how this can be accomplished with a diode matrix.

First of all, the system accuracy (and thus resolution) is 1%. In binary code operation, this suggests a 7-bit system, which has resolution of 1 part in 128, slightly better than required. Having established the required number of bits to achieve the proper resolution for the converter, we select a 7-bit converter and proceed with the matrix design.

The first band of 8-to-14 psig would require 7 vertical matrix lines, each line diode-connected (as described in Chapter 3) to represent the numbers from 8 to 14. This matrix is shown in Fig. 12-6.

With the matrix connected in common at the bottom, all values between 8 and 14 psig will actuate the valve. whereas all other values (from 1 to 127) will be grounded through one or more of the diodes and will not actuate the valve.

(In this instance the converter could be a modified chronometric type such as described in chapter 8, Fig. 8-5. The clock pulse output then is multiplexed to the flip-flop chain shown in Fig. 12-6 instead of going to the binary chain shown in Fig. 8-5 for recording purposes.)

If we wish to add the range 67 to 80 psig (that is, to have the valve remain open in the range from 67 to 80 psig), we require 14 additional vertical lines programmed is sequence to represent the numbers from 67 to 80. This is shown in Fig. 12-7. These two matrices will cover the situation and will operate over the double band of values with a resolution of better than 1%.

Scale Change

In the process problem we chose an arbitrary maximum range of 127 psig and performed control actions in the pressure bands of 8-to-14 psig and 67-to-80 psig, with a system accuracy of better than 1%. A simple change in scale factor would alter the ranges. For example, if the maximum pressure were 80 psig, and all other conditions are to remain exactly as described, the pressure of 80 psig would correspond to 127 psig, and all other values are found by using the scale factor 127/80 as follows:

8	13
14	22
67	107
80	127

In this case we would set up the matrices so that the matrix lines from 13 to 22 and 107 to 127 would be activated. We thereby control the system with 80-psig maximum pressure, as desired, to an accuracy better

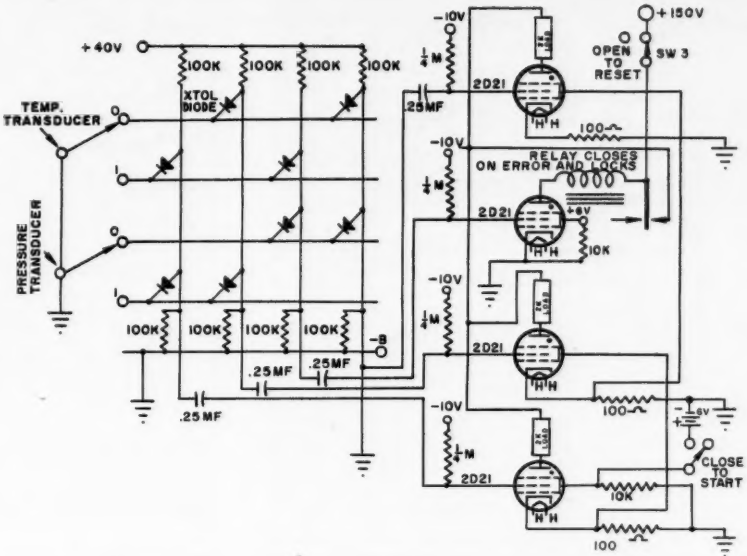


Fig. 12-8. Use of gating tubes assures proper sequence of action. Each vertical matrix line is connected to a thyratron gate tube, which cannot be fired until the preceding gate tube fires, thereby applying screen voltage to the gate tube.

than 1%, and the valves will open in the range 67-to-80 psig (lines 107-127 on the matrix) and in the range 8-to-14 psig (lines 13 to 22 on the matrix).

Determining the Number of Diodes

In general, the number of diodes required can be determined simply by multiplying the number of bits required for the system accuracy by the sum of the bands of numbers to be covered. Thus a system with a resolution of 0.1% which covers the range from 100 through 110 and 856 through 870 requires the following number of diodes:

10 bits required for 0.1% accuracy
100-110 band = 11 units
856-870 band = 15 units
Total band units = 26
26 x 10 = 260 diodes required.

It is obvious that the construction cost goes up directly with the band of values to be covered and exponentially (powers of 2) with increase of accuracy. In other words, it is more economical to design a system with less accuracy and wider operating band than one with high accuracy and narrower operating band. This assumes that the construction cost of the matrix varies directly with the number of diodes, which is generally true. Note that increasing the accuracy of the operation does not increase the number of converters used, there being only one. Therefore, although one part of the process requires 2% conversion accuracy and another part 0.1%, the converter used must be capable of digitizing with a resolution of 0.1%. In the case of the 2% readings, the residual bits can be discarded and only the most significant bits used for the comparison and control matrix.

Memory

The program to this point does not specify a specific order in which the control action is to take place. For example, in the process shown in Fig. 12-5 the temperature could reach the required value to open the valve before the pressure, or vice versa. However, it may be necessary to specify that the temperature first reach its correct value, then the pressure is to attain its correct value—but never the reverse. If something goes wrong with the process and the pressure reaches its limiting valve first, it may be desired to shut off the process. We imply here the necessity of a *memory*, which can recall what has already happened and, before performing the required logic, will see if the correct order of events has taken place in the past.

There are various techniques for accomplishing this. The simplest uses a diode matrix and a gating arrangement, as shown in Fig. 12-8. Here the transducers each operate a dp-st switch when certain desired temperature and pressure values are reached. When both are in position 0, the left vertical line goes positive and sends a positive signal to the control grid of the bottom thyratron, causing it to fire (if the start switch has been closed). The cathode of the bottom thyratron then goes 6 v positive, which enables the next thyratron, whose shield grid is connected to the bottom cathode. This second thyratron will then fire *if the temperature switch is advanced to the* 1 *position while the pressure switch remains at* 0. Thus a fixed sequence of pressure and temperature values must occur in proper order to obtain operation of the relays in the plate load of the thyratrons. The third vertical matrix line fires the 3rd thyratron in the event that the temperature falls again to 0 while the pressure remains at 0, indicating that something has gone wrong.

The tubes used also provide memory to keep the valve open during the interval of time the matrix is not receiving a signal. In a practical circuit, multiplexing is used, as was pointed out. This means that a signal is fed to the matrix only during the interval of time that the particular sample is being taken. Some memory is required to hold the valve open during the balance of the time. The power-handling tubes used (thyratrons) remain in a conducting state once conduction has begun. Therefore, each tube serves the double purpose of providing a gating bias for the next operation in the desired sequence and remembering for its own matrix during the time when it is not receiving a sample.

There is no limit to the steps in a sequence of events that can be incorporated in digital control of a process. The principles described can be applied directly and the problem becomes one of repeating the necessary circuits —matrices and diode connections—irrespective of the

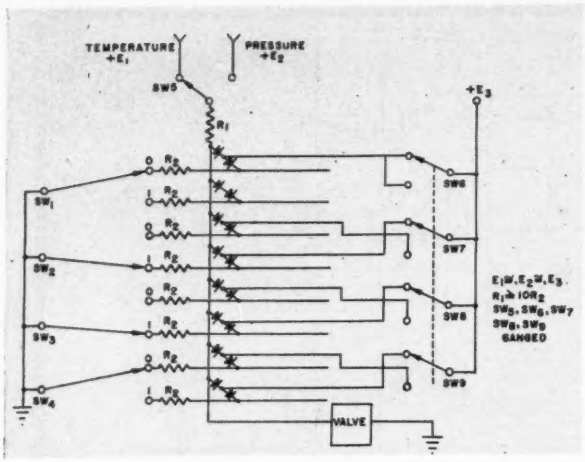


Fig. 12-9. Trunking a matrix so that it controls valve action first at 6 units (of temperature) and then at 8 units (of pressure). This is done by back-biasing the matrix diodes by switch at right. When in position shown, switch has biased diodes so that the valve is actuated (i.e. El reaches valve) when switches at left are in position 0110, as shown. When SW5-9 is thrown into bottom position, E2 reaches valve when switches at left are in 1000 position, corresponding to 8 units of pressure.

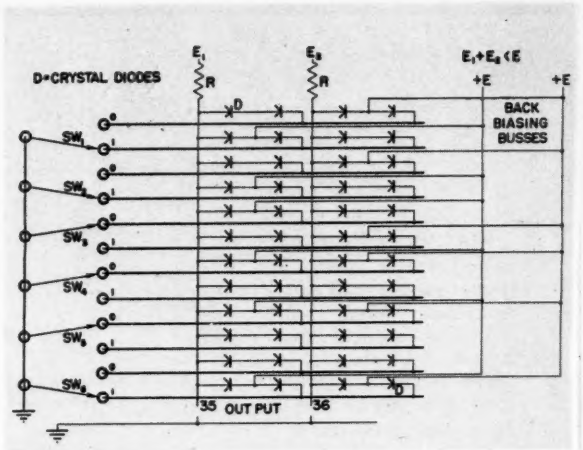


Fig. 12-10. Matrix can cover a wide range of values by back-biasing the matrix diodes. Diodes in the line at left are biased so that the line activates on input 35 (100011); next line activates on input 36 (100100).

number of steps. The engineer programming the process must have a complete quantitative knowledge of the process to be controlled, the sequence in which events are to take place, and any alternate programs he wishes the process to follow in event that the original program is not followed. Without this information no process control can be accomplished in any form—digital or any other. There are many processes which are operated today on a more or less qualitative basis. Before they can be made self-controlling, with digital or any other techniques, they must be investigated completely. It is surprising how little knowledge is available on even simple processes.

Trunking Matrices

In Chapter 3 it was pointed out that a matrix could be trunked—that is, the matrix can have its diode connections changed an any way desired. This can be accomplished by suitable back-biasing and subsidiary logical networks and becomes of high practical value when extensive programs are involved which would require many matrices, each containing many diodes.

Suppose we wish to have, simultaneously, a single matrix multiplexed (time-shared) as a comparison and logical network. That is, suppose we wish to use the matrix part of the time as a temperature-comparison matrix and part of the time as a pressure-comparison matrix. Let us say that we are working with a go, no-go arrangement again where the temperature matrix is to activate the line valve at 6 units and the pressure at 8 units. Previously we used separate matrices for the temperature and for the pressure (Fig. 12-5); we will now use a single matrix to accomplish the same thing.

Let us trunk the matrix by back-biasing the diode connections as shown in Fig. 12-9. When a diode is back-biased it is effectively disconnected; when it is not back-biased it can conduct. Here a double-diode arrangement is provided to permit the electrical back-biasing of the diodes. We arrange the biasing so that when the temperature signal (in digital form) is fed to the comparison network, the matrix is programmed to 6 units. This is done by back-biasing all of the diodes other than the ones that activate the matrix at 6 units (0110).

Previously we used a trunking matrix to distribute the various signals to the programmed matrix. This is now discarded because all of the input signals—in this case two—are to be fed to the single trunked matrix. This matrix is replaced by another which is driven by the multiplexer as before. However, each line is connected or programmed to the diodes requiring back-biasing. Thus, when the scanner is reading pressure, this back-biasing matrix connects (in parallel) to the diodes in the comparison matrix to provide a fixed level voltage, disconnecting the required diodes to make the matrix line activate at 6. As the scanner steps to pressure, this back-biasing matrix steps also to a second line which back-biases those diodes, now making the control and comparison network activate on 8.

We can now have the matrix cover a range of values, simply by extending the back-biasing connections. This is shown in Fig. 12-10, where the back-biasing lead connects simultaneously to two separate vertical lines of the comparison matrix. This programs the first martix line to the number 35 and the second to 36. This could be carried one step further by having the single line successively represent 35 and then 36, but generally this is not a practical requirement in process control.

To summarize, a process which operates in discrete operations has been detailed. It has been shown that control with accuracy of 0.1%, the practical limit at the present time, can be attained digitally. In addition, any sequence of events can be programmed. The use of a trunking matrix to perform several comparisons in multiplex was explained. All operation rests on predetermined engineering specifications which require detailed knowledge of the nature of the process.

Electron Photography

RAPID STRIDES have been made in the new field of electrophotography or electrostatic photography. Briefly, electrophotography is a method of producing a permanent image upon any surface that can be coated with a photoconductive paint. The paint has a special characteristic—it will hold an electrostatic surface charge for an indefinite time in the dark and, when exposed to light, the surface charge is grounded through the coating.

When a film negative or positive is laid over the charged surface and then exposed to light, only the light exposed areas are discharged, leaving an invisible duplicate image upon the surface composed of an electrostatic charge. The picture is made visible by applying finely ground powders with a camel's hair brush or a magnetic brush. The picture is then fixed permanently by applying heat, a coating of lacquer, or a mist coat of solvent. The entire process is accomplished in minutes.

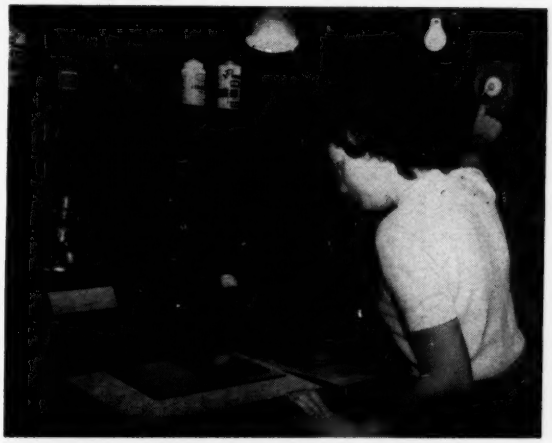
This photoreproduction method is well suited for massive contact reproduction of full-scale original drawings, either negative or positive. It is adapted to either the pencil-line or the scribe-line method of making tooling and template layouts. It is particularly interesting for fast production of dials, nameplates, and schematics—from original line or halftone photographs, either pilot models or continuous production runs.

Applications include also photogrammetry as an accurate short-cut method for compiling maps and charts. Aircraft plants and electronic manufacturers can use it as an inplant source for check printing or original drawings, production of etched circuits, metal and plastic templates, dials and nameplates for pilot models, etc.

The process eliminates the need for developing tanks, fixing baths, water washout racks, dark room storage areas, and practically all chemicals normally used in photography. Loss from accidental exposure is eliminated and materials can be precoated and held in storage with no loss in efficiency.

(Photos by courtesy of the Truline Process Co., St. Louis 1, Mo.)

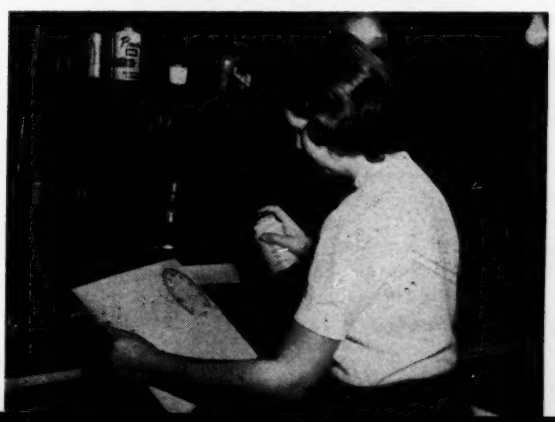
Spray coating the photo-conductive paint (ordinary shop light).



Exposing to photo-flood lamp (1 second).

◆ Developing with the magnetic brush.

◆ Fixing with lacquer or krylon.



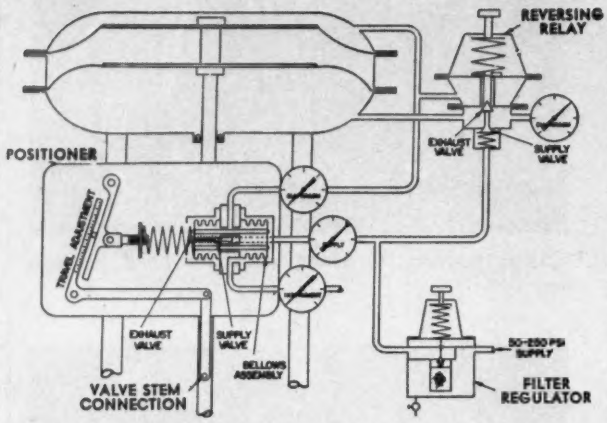


Fig. 10-1. Conventional positioner for diaphragm actuator can be adapted to cylinder or double-diaphragm actuator by use of reversing relay. Reversing relay produces an inverted signal which is used on opposite side of cylinder. (Photo courtesy Fisher-Governor Co.)

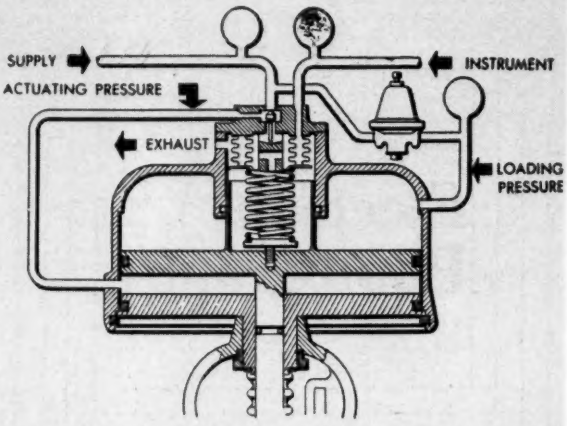


Fig. 10-2. Annin "Domoter" uses a built-in force-balance positioner for a cylinder actuator with pneumatic cushioning (obtained from regulator).

Positioners for

Control Valves—No. 10

Cylinder-type valve actuators require positioners, which may be either external auxiliary devices or built into the cylinder actuator. The positioner can load either one or both sides of the cylinder. Here is a survey of the various types of integral and external positioners now available for cylinder actuators—from small built-in units to electrohydraulic units with outputs of hundreds of hydraulic horsepower.

ALTHOUGH the primary use of all the positioners described thus far is with diaphragm-actuated valves, they can be adapted to the positioning of cylinder-actuated valves. For example, the use of a reversing relay, as shown in Fig. 10-1, produces a balanced output which can be applied to the opposite sides of a cylinder or balanced-diaphragm actuator. Here the reversing relay produces an inverted signal, increasing pressure when the output of the positioner decreases, and vice versa. The two signals of opposite phase are used to operate a cylinder or double-diaphragm actuator, as shown.

A positioner can be used to operate a cylinder without the reversing relay by operating the cylinder against a cushioning volume of constant pressure, as obtained from a pressure regulator. In general, however, the positioners described thus far are for use with diaphragm-actuated valves, and the following positioners are designed primarily for cylinder actuators. (Here again there is no clear distinction—the cylinder actuators can be adapted for use with diaphragm actuators.)

Cylinder Actuators with Built-in Positioners

The following two cylinder actuators have built-in positioners—that is, the positioner-cylinder unit is offered as a package. Both use the force-balance principle, and both use pneumatic cushioning.

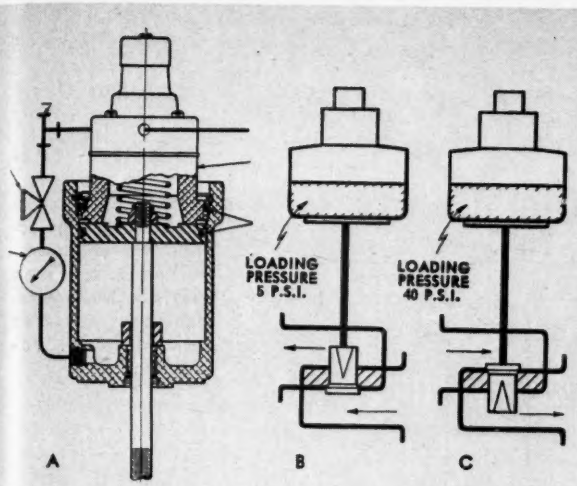


Fig. 10-3. Conoflow "Conomotor" uses a built-in force-balance positioner and cylinder operator with pneumatic cushioning (obtained from regulator). Pneumatic cushioning makes possible the handling of a wide variety of flow conditions, as shown in B and C.

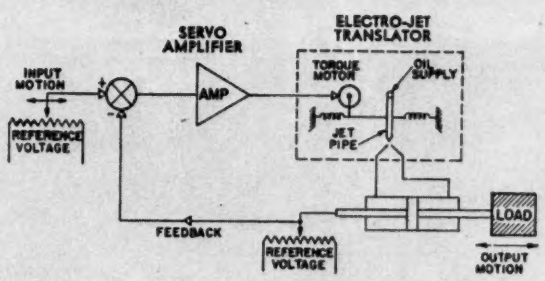


Fig. 10-4. Askania "Electro-Jet" electrohydraulic positioner accepts electrical input signal and develops output of more than 40 hp.

Cylinder Actuators

C. S. BEARD
Foster Engineering Company

The Annin Company

Fig. 10-2 shows the "Domotor" actuator, which is a cylinder actuator with built-in positioner. The force-balance principle is used. Downward force exerted by the bellows receiving the instrument signal is balanced against upward force exerted by a spring attached to the piston. Any unbalance causes the pilot valve to change the operating pressure on the bottom side of the piston. The space above the piston (dome section) is loaded by a predetermined air pressure from a regulator. Use of pneumatic pressure rather than a spring to oppose the piston motion has three advantages—(1) the piston can move through a long stroke because no room is needed for a heavy, long actuator spring, (2) stability is increased, and (3) flexibility is increased as the cushioning force is easily changed.

Conoflow Corporation

The "Conomotor" cylinder actuator (Fig. 10-3) uses a positioner similar to that shown previously in Fig. 9-11, and a cylinder actuator with pneumatic cushioning. Here again the use of pneumatic cushioning makes possible long strokes, high accuracy of positioning (within 1 part in 500), and rapid and stable response. Fig. 10-3 also shows the flexibility obtained by pneumatic rather than spring cushioning. Due to the unidirectional thrust of all single-seated valves, only a small percentage of the maximum supply pressure is needed for handling the thrust. For example, an unbalanced force of 1200 pounds due to differential pressure across the plug area can be accomodated by a loading pressure of 5 psig when the flow is as shown in "B," or by a loading pressure of 40 psig when the flow is as shown in "C." Such versatility is difficult to obtain in spring-opposed diaphragm actuators.

Positioners for External Cylinder Actuators

The preceding two positioners described are for use with pneumatically-cushioned cylinder actuators in which the pressure in the cushioning volume is held constant by a regulator.

Other types of positioners for cylinder actuators are available which adjust the pressure on *each* side of the piston, increasing the pressure on one side while decreasing it on the other side. This has the advantage of higher power positioning as the full supply pressure can be used to drive the valve either open or closed. Although the following are listed under the heading of "Positioners for External Cylinder Actuators," several of the following positioners are supplied with the cylinders as a package unit.

Askania Regulator Company

Fig. 10-4 shows the "Electro-Jet" electrohydraulic servo system, which accepts an electrical input signal and causes a proportional motion of a piston in a cylinder actuator. A feedback signal, obtained from a potentiometer attached to the piston stem is compared with the

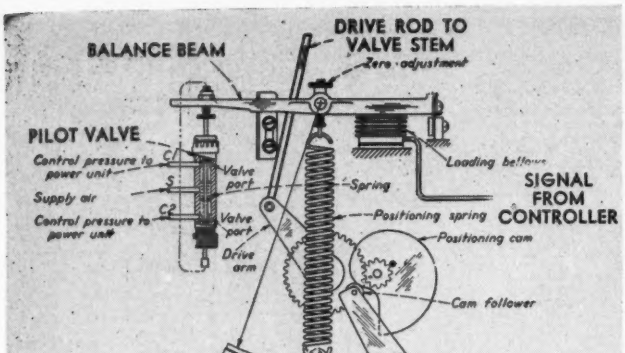


Fig. 10-5. Bailey Meter positioner is force-balance unit with cam that characterizes the relationship between instrument signal and valve-stem position.

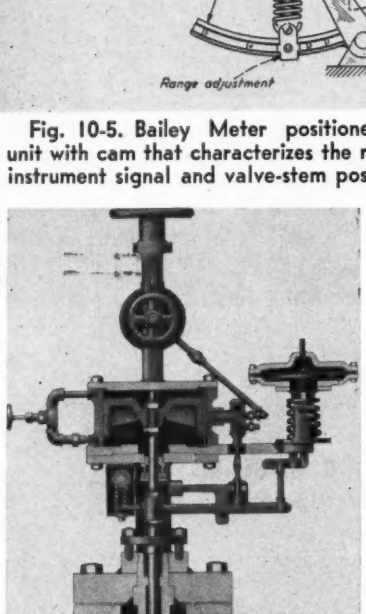


Fig. 10-6. Copes-Vulcan positioner for cylinder is of position-balance type. Pilot adjusts pressures on both sides of cylinder actuator to obtain proper positioning. Feedback to reposition pilot is via mechanical linkage.

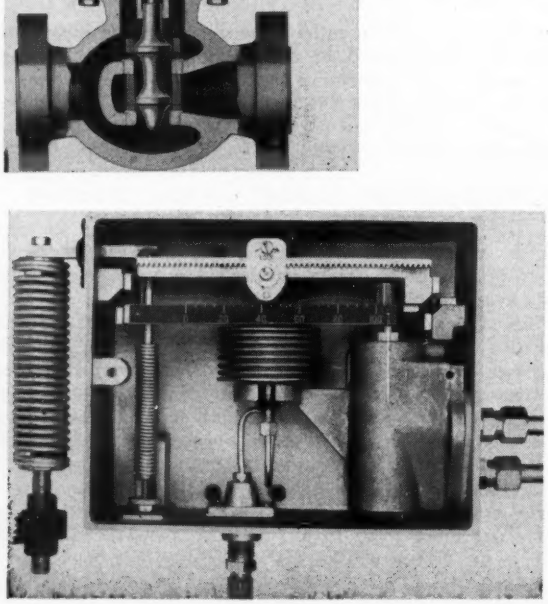


Fig. 10-7. Foxboro Power Positioner is force-balance unit for cylinder actuator. Pilot adjusts pneumatic or hydraulic pressure on both sides of piston until proper positioning is achieved, at which time the opposing forces are in balance.

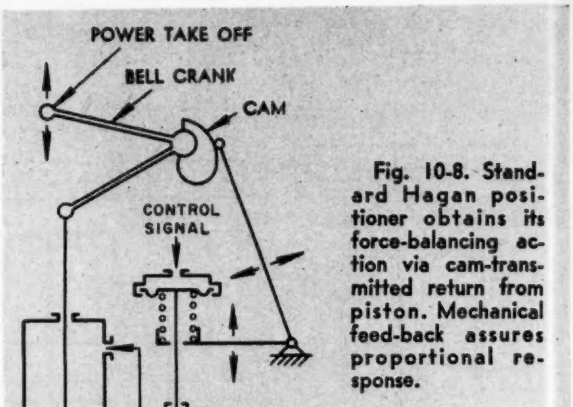


Fig. 10-8. Standard Hagan positioner obtains its force-balancing action via cam-transmitted return from piston. Mechanical feed-back assures proportional response.

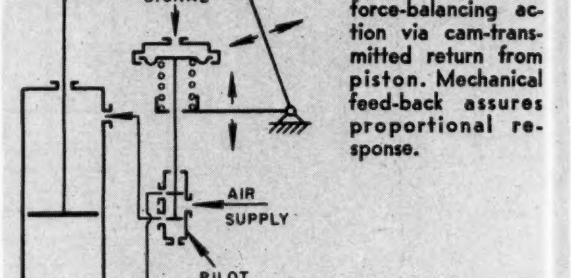


Fig. 10-9. This Hagan pneumatic-hydraulic pilot uses 2-stage pilot to develop higher output force (40 usable control hp).

input signal; any difference between the two is amplified and delivered to a torque motor that positions the hydraulic jet unit. This jet delivers high-pressure hydraulic fluid to either end of the piston, which moves until the feedback signal equals the input signal.

This electrohydraulic servo can deliver an output of more than 40 hp, and positions to an accuracy of better than 0.5%.

Bailey Meter Company

The positioner shown in Fig. 10-5 is a force-balance unit with a cam that characterizes the relationship between the instrument signal and the position of the valve stem. This is done simply by a shaped cam between the drive rod for the valve stem and the positioning spring. Except for this feature the unit is a conventional force-balance positioner, with the balance beam balanced between the force exerted by the bellows receiving the instrument signal and the opposing force exerted by the positioning spring. Any unbalance causes the pilot to change the air pressure on *both sides* of the cylinder actuator with which the positioner is used.

Use of a cam to characterize the signal-position relationship in a positioner extends the usefulness of equipments such as gate valves and most plug cocks, which do not have characteristics suitable for many control purposes.

Copes-Vulcan

Fig. 10-6 shows a position-balance-type positioner with a cylinder actuator. The instrument signal is applied to the spring-opposed diaphragm unit at top right. This unit moves the pilot which admits either hydraulic or pneumatic pressure to one side of the cylinder while bleeding it from the other—until the valve stem reaches proper position. Feedback to the pilot is done mechanically by linkage.

Foxboro Power Positioner

The Power Positioner shown in Fig. 10-7 is designed for throttling-action cylinder actuators. The spring shown at the left is connected to the cylinder stem and develops a force proportional to stem displacement. This force is balanced against a force developed by the bellows which receives the instrument signal. The small spring shown within the case is a zero spring. Hence the unit is a force-balance type.

Unbalance of the forces moves a 4-way pilot which admits pneumatic pressure to one side of the cylinder being positioned while bleeding the other side. The two lines shown at the right are the supply inlet and exhaust lines; the two lines to the cylinder cannot be seen as they come out of the rear of the pilot.

Hagan Corporation

The positioner shown in Fig. 10-8 is the standard Hagan positioner, which accepts a pneumatic input signal from the instrument controller and develops a proportional pneumatic or hydraulic output signal for positioning a cylinder actuator. The 4-way pilot is force balanced between the downward force due to the diaphragm and the upward force due to the spring which is recompressed by the feedback action. A cam is used to characterize the response.

The pilot valve shown in Fig. 10-9 is a *pneumatic-hydraulic pilot* that accepts a 0-to-30-psig pneumatic input and translates it into a hydraulic fluid output for systems requiring a maximum of 2000 psig supply and flow capacities to 80 gpm. The hydraulic output can be used to control a high-power cylinder valve actuator to obtain positioning accuracy better than ¼% full stroke. Feedback from the power unit to the pilot valve is done mechanically, as shown, to obtain proportional reponse.

The *electrohydraulic pilot valve* shown in Fig. 10-10 can be used to control large cylinders in high-power actuators. It operates with a supply pressure of up to 2000 psig and is available in capacities to 600 gpm (up to 300 usable hydraulic horsepower). In addition to the high power output, positioning accuracy of 0.1% full-scale can be obtained while hysteresis is 0.05% of full stroke. The dynamic characteristics are obtained by use of (1) a permanent magnet (force) motor with d-c signal input, (2) a spinning pilot valve whose spinning motion reduces hysteresis, and (3) a 2-stage hydraulic pilot.

Republic Flow Meters Company

The positioner shown in Fig. 10-11 also has a cam that characterizes the relationship between instrument signal and valve position. Except for this feature it is a conventional force-balance positioner for use with a cylinder actuator.

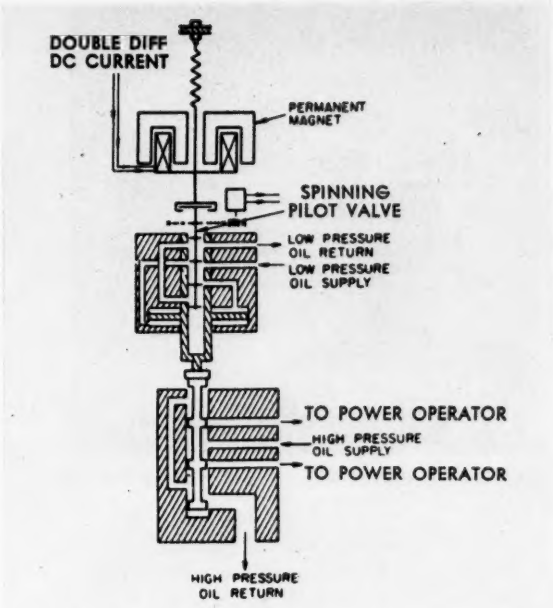


Fig. 10-10. Electrohydraulic positioner of Hagan Corporation is for high-power cylinder actuators (up to 300 hp output). Spinning pilot is used to reduce hysteresis. Elecfrical signal is used to position a 2-stage pilot controlling hydraulic pressure to the cylinder. Feedback from the cylinder is done via a feedback potentiometer attached to the cylinder; unless the cylinder position is as called for by the electric input signal, an amplified d-c signal is delivered to the input shown.

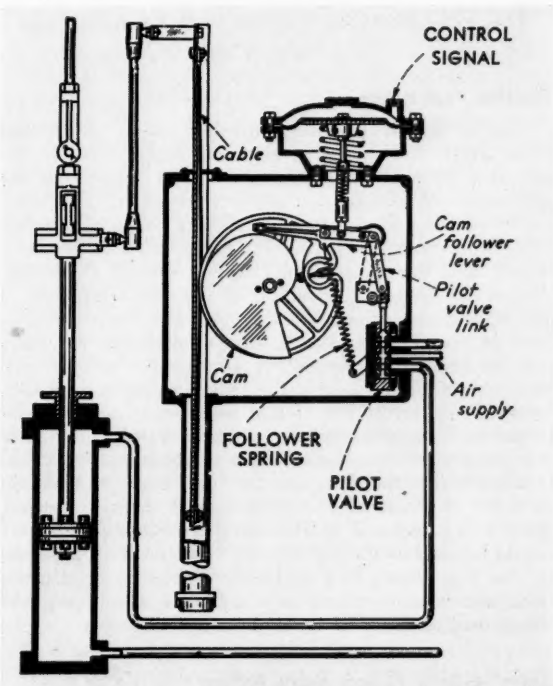


Fig. 10-11. Republic Flow Meters positioner has cam that characterizes the relationship between instrument signal and piston position.

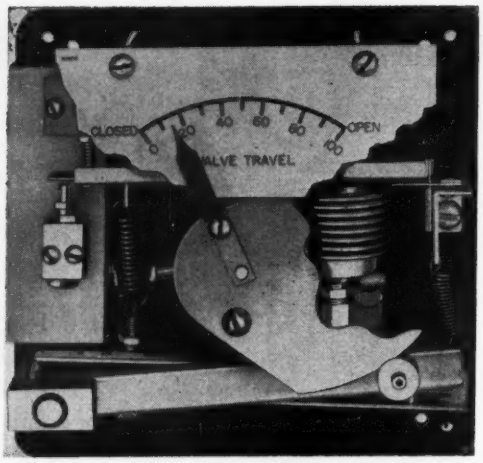


Fig. 10-12. Positioner with valve-stem-travel indicator.

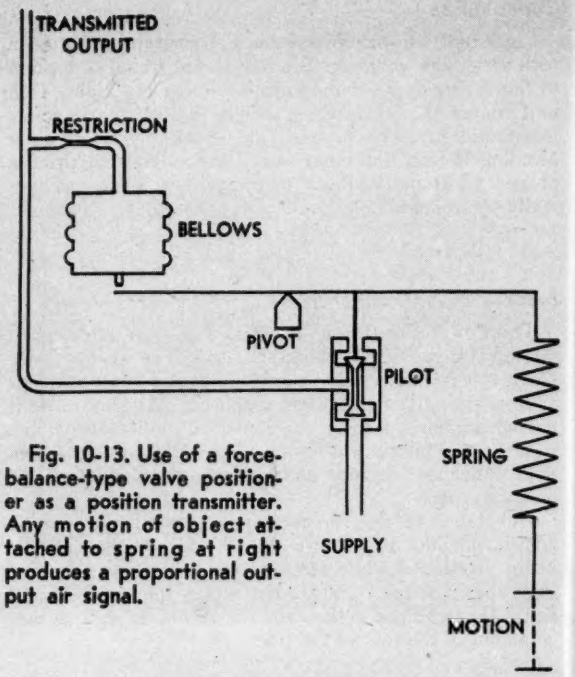


Fig. 10-13. Use of a force-balance-type valve positioner as a position transmitter. Any motion of object attached to spring at right produces a proportional output air signal.

Other Uses for Positioners

Travel Indicator

Fig. 10-12 shows a positioner equipped with an indicator that shows valve stem position.

Position Transmitter

Use of remote position indication is so useful that most firms furnish their valve positioners adapted for use as a position transmitter. Fig. 10-13 shows how the positioner is used as a position transmitter. The beam to which the pilot is attached is force balanced between two forces—one proportional to the position to be monitored, and one proportional to the output air signal. Hence any change in position of the object attached to the spring causes the pilot to produce a proportional change in output air signal, which rebalances the beam via the bellows. As the output air signal is proportional to the monitored position, the output signal can be used as a remote indication of that position.

An early application of position transmission was in conjunction with a contact plate to sense the top of the catalyst bed in the chamber of a "cat" cracker. A change in level of about 10 ft was translated through a worm gear into a vertical motion of a few inches so that it could be used as the input to a remote position indicator of the type shown in Fig. 10-13. The position indicator was calibrated to obtain a 3-to-15-psig air output with movement of the plate through its entire range.

Developing a Pulsing Valve Action

Although normal use of the positioner is to obtain stability and eliminate cycling of the control valve, the positioner can be used to do the opposite. A positioner can be re-built to cause a valve to pulse so that the flowing product will not plug the seat.

A small bellows is inserted just ahead of the nozzle. Any controller output pressure that is applied to the positioner will cause the bellows to expand and to build up pressure to the actuator. Stem movement will rapidly move the flapper away from the nozzle to retract the bellows. This pulsing effect will continue. The amplitude of the pulsation can be varied by adjustment of the stroke of the bellows; the frequency by a variable restriction in the air line to the actuator.

Snap Action for Limit Control

Instrument engineers often have to deal with systems which require two controllers—one to control one variable until the value of another variable reaches a predetermined limit, at which point the second controller takes over. Some systems use controlled output pressure from one controller as the supply pressure for the second controller; others use a limit controller, which allows the variables to fluctuate until they reach predetermined limits.

One particular installation known to the author held a constant pressure on a gas line until the flow reached a given value. The flow was to be kept below this limit. Considerable economy was possible by using two controllers, but only one diaphragm control valve. A valve positioner (Fig. 10-14) was employed as a snap-acting relay operating a three-way pilot for selection of the controller which was to operate the gas valve. If the end of the deflection beam (normally connected to the valve stem) is held rigid, the bellows will operate the pilot with a snap action. The range spring may be set at any predetermined point. This snap-acting device can be used on the output of any pneumatic controller to sound alarms or to put another instrument into service.

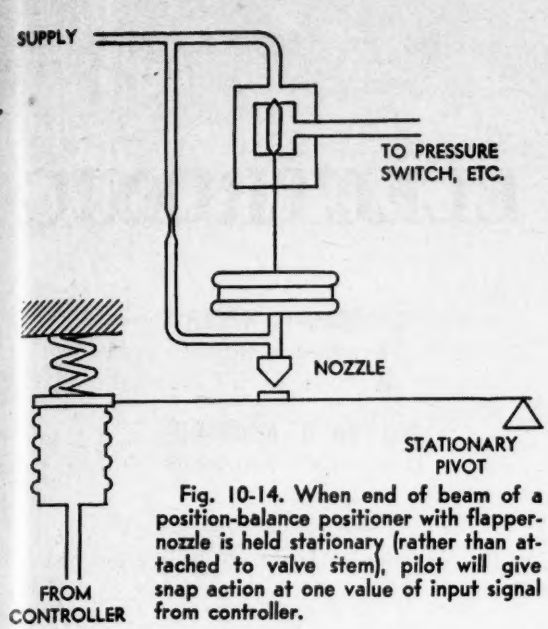


Fig. 10-14. When end of beam of a position-balance positioner with flapper-nozzle is held stationary (rather than attached to valve stem), pilot will give snap action at one value of input signal from controller.

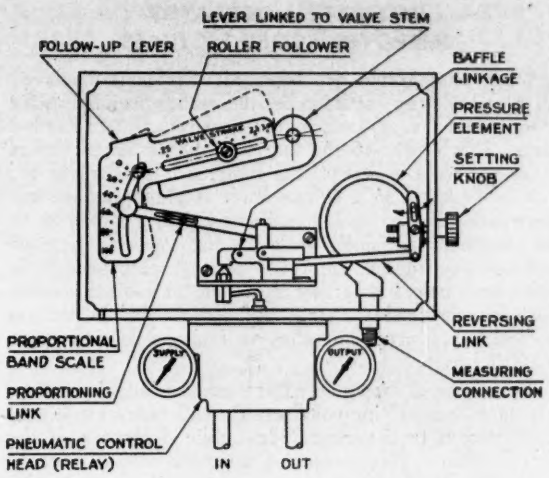


Fig. 10-15. Pressure pilot for positioning a valve is similar to position-balance-type positioner. Pilot produces output signal proportional to static line pressure measured by the Bourdon element.

Use as Pressure, Level, or Receiver Controller

Fig. 10-15 shows a pressure pilot. Like the positioner described in Fig. 9-5, it contains a flapper-nozzle unit that controls a pilot relay. The flapper is moved by the Bourdon element and is repositioned by mechanical feedback from the valve stem. Here the instrument develops a 3-to-15-psig output signal proportional to static line pressure.

The same principle is used as a level controller, a position controller, etc. This type of controller can be considered an intermediate device between self-operated regulators and full instrument-type controllers.

Evaluation of Positioner Operation

Criteria for evaluating valve positioners have not yet been standardized. The companies that have run accuracy, sensitivity, or frequency-response tests on their equipment emphasize different characteristics and, in most cases, state results in different forms.

Good design considerations include the following:

(1) Valve stem movement should be linear with respect to controller output; (2) operation should be insensitive to variations in supply pressure; (3) small motion of actuator stem should cause large change in pressure to actuator; (4) air consumption should be low; (5) small cyclic changes in controller output should be dampened; (6) the pilot valve should operate on the small movement obtained through the balancing mechanism of the positioner; the pilot valve must, nevertheless, have high capacity in order to load or unload the actuator for rapid action.

Summary

Hysteresis or resistance to movement can cause a valve to lose much of its value as a flow-control element. Hence many specifications require that a control valve show evidence of movement with a change in loading on the actuator of not more than 0.1 psi. This condition is not too difficult to obtain *under test conditions*. Under *operating conditions*, however, improper packing or other factors can increase hysteresis or friction. Valve friction requiring ½ to 1 psi on the actuator to cause movement is not uncommon. One-psi change should cause 1/12 of total movement, or 8⅓% when the actuator operates in a range of 3-to-15 psig. Reference to any of the flow characteristics in Chapter 3 will show that an inaccuracy in position of 8⅓% could cause large discrepancy in desired flow rate, particularly if it occurred near the open position of an equal-percentage plug. The necessity for a comparatively large change in controller output to cause valve movement nullifies the advantages of a sensitive controller.

To minimize these adverse conditions the valve positioner was developed. It has two main characteristics: (1) *sensitive response* to changes in controller output pressure, and (2) *reproducibility* of stem position. A published response figure is 0.1% of full range. Assuming a 3-to-15-psig system, this would mean that a change of 0.015-psi will open the pilot valve of the positioner and allow full supply pressure to be applied to the actuator for moving the stem. One valve positioner will reproduce valve stem position within 0.2% of full stroke between maximum and minimum position with valve friction of 8%, which in this case is 1 psi.

Possibilities of ingenious uses of valve positioners are limitless. The valve positioner has become indispensable in its orthodox application and insures the correct position of a diaphragm-actuated or cylinder-actuated valve under severe operating conditions. The present trend towards greater use of springless diaphragm actuators, cylinder actuators, and single-seated valves emphasizes the importance of valve positioners.

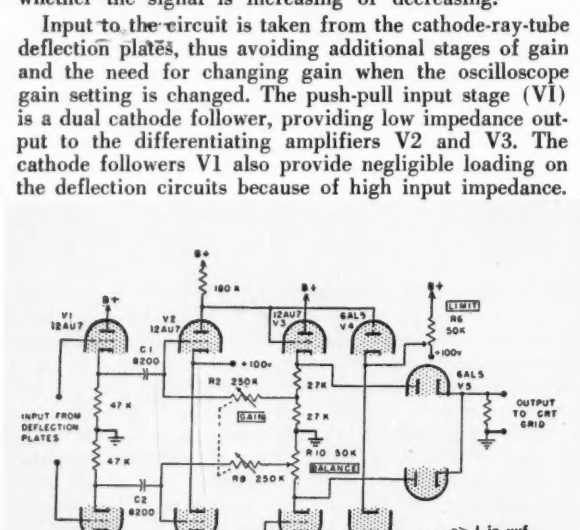
ELECTRONIC

INTENSITY MODULATOR IMPROVES SCOPE PICTURES

When photographs are taken of waveforms displayed on a cathode-ray oscilloscope, the results usually suffer from marked variations in the density of the recorded trace. This is due to the fact that the faster the beam moves across the screen, the dimmer it appears to be. For example, when a square wave is photographed, the steep sides of the wave may be so lightly exposed as to be practically invisible, while the flat tops and bottoms are heavily exposed. Improved photographic techniques offer some help, but further improvement is often needed. This circuit produces striking improvement in the recorded traces, accommodating writing speeds over about a 100:1 range.

Variations in sweep speed are compensated for by applying an intensifying voltage to the cathode-ray-tube grid proportional to the magnitude of the *derivative* of the signal voltage. This correction voltage is always positive, regardless of signal derivative polarity, because brightening is needed whenever the spot is moving rapidly, whether the signal is increasing or decreasing.

Input to the circuit is taken from the cathode-ray-tube deflection plates, thus avoiding additional stages of gain and the need for changing gain when the oscilloscope gain setting is changed. The push-pull input stage (V1) is a dual cathode follower, providing low impedance output to the differentiating amplifiers V2 and V3. The cathode followers V1 also provide negligible loading on the deflection circuits because of high input impedance.



The output of V1 is differentiated in the RC circuits R2-C1 and R8-C2, to obtain outputs proportional to the vertical spot velocity. Because of the negative feedback path around stages V2 and V3, the time constants are reduced by a factor of six; the feedback amplifier also provides differentiation over a much wider range of input rates than would be available from a simple RC circuit without feedback.

The full-wave rectifier V5 selects a positive-going output from one side of the circuit or the other. If the modulator were used with a cathode-modulated CRT instead of a grid-modulated one, V5 would have to be connected to select a negative-going signal. The 6AL5 diode (V4) is a plate-catching limiter to prevent excessively large intensifying signals from being applied to the cathode-ray tube. Limiting level is adjustable by R6.

Circuit gain is adjusted by the dual 250K potentiometer R2-R8. The two sides of the circuit are balanced by adjustment of the 50K potentiometer R10 (to obtain equal intensity for positive- and negative-going signals).

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Key Electric Corp.

and

MILTON H. ARONSON
Instruments & Automation

The only modification to the oscilloscope required is addition of a crystal diode (Type CK 708) to provide d-c restoration. If this change were not made, the average trace intensity would fluctuate with the amplitude and duration of the corrective modulating voltage.

Input: Direct from deflection plates, at d-c level of about 150 v; may be capacitively coupled instead, using 5-megohm grid resistors for V1, returned to 100v.

Frequency range: 100 to 15,000 cps.

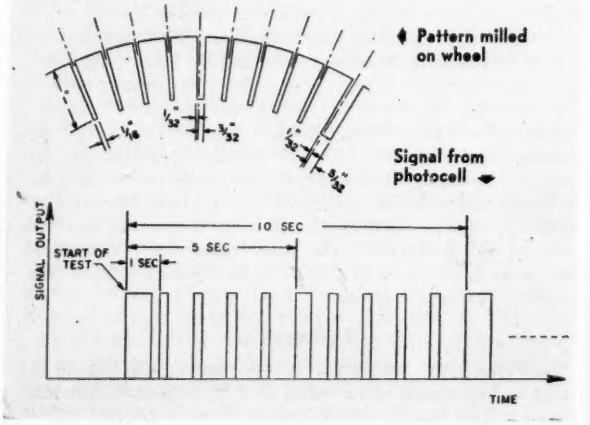
Range of writing speeds that can be accommodated: About 100:1.

B Supply: 250 v dc at 24 ma.

Source: Robert F. Kemp, School of Medicine, U. of California at LA, and Veterans Administration Hospital, Long Beach, Calif.; also *Review of Scientific Instruments*, December, 1955.

TIMING MARKER GENERATOR PRODUCES 1-, 5-, AND 10-SECOND MARKERS

Although standard millisecond and microsecond timing signals can be obtained from tuning fork circuits, crystal oscillators, WWV transmissions, etc., many tests require timing markers of seconds or more. This circuit uses a 1-rpm synchronous motor to rotate a slotted disc in front of a photocell. Disc is milled so that light falls on the photocell at 1-second intervals; every fifth slot is twice as wide to identify the 5-second intervals; every tenth slot is triple width. The relay in the plate of the



CIRCUITRY

The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

output thyratron is used to put marks on paper or film via solenoid pens or lamps.

A gas-filled CE-22-D phototube (similar to RMA type 1P41) is the light detector; it is triggered each time a slot passes in front of the phototube. A-c line voltage is applied directly to phototube and thyratron; hence grid of thyratron recovers control on negative swing of line voltage. Thyratron sensitivity is adjusted by 1K pot in voltage-divider network.

Selector switch in anode circuit of thyratron provides either manual or automatic starting of the timing. When on automatic, the timing starts whenever the switch to the ignitor or oxidizer valve (for rocket propellants—in which this circuit was used) was closed.

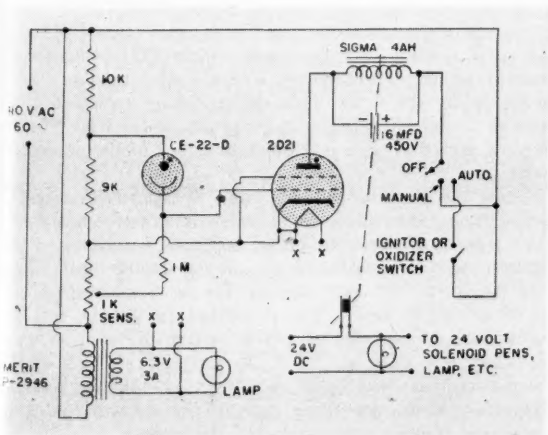
The 16-uf capacitor across the relay prevents the relay from chattering at a 60-cps rate. The thyratron fires when the grid-to-cathode voltage is above —2 volts (depending somewhat on individual tube characteristics and exact heater voltage). The 1K sensitivity potentiometer can vary the bias from 0 to —5.5 volts.

With a GE number 1120 light source (6-8 volts), the output from phototube was approximately 1.5 v. (Shield was placed over photocell-light unit.)

Output: 1 second markers of pattern shown, coded every 5 and 10 seconds.

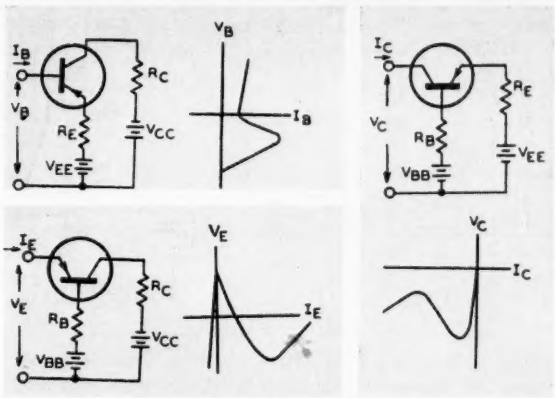
Accuracy of timing: Limited by a-c supply to 1/60 sec. Also limited by precision of milling of slots.

Source: Loren E. Bollinger, Rocket Lab., Ohio State University, Columbus 10, Ohio; also *Instruments & Automation,* July, 1956.



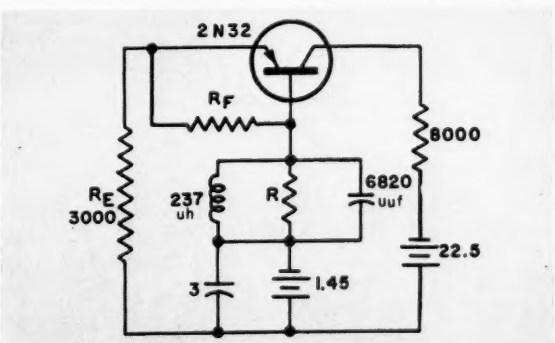
POINT-CONTACT-TRANSISTOR OSCILLATOR SHAPES BASE-INPUT CHARACTERISTIC TO IMPROVE STABILITY

As shown in the small diagrams, the characteristic (plot of voltage vs current) of either the base, emitter, or collector of a point-contact transistor has a negative-resistance region where current decreases as voltage increases. If a resonant circuit is included in the transistor



circuit, and if the transistor is operated in any of these negative-resistance regions, the circuit will oscillate. The stability of the oscillation can be improved both by proper loading and by "shaping" the negative-resistance characteristic by either voltage or current feedback. The circuit shown uses voltage feedback to increase stability of oscillation; it is said to have "voltage-controlled input characteristic."

The 125-kc oscillator shown has a parallel-resonant circuit in its base circuit. Feedback resistor R_F "shapes"



the input negative-resistance characteristic so that maximum stability results.

Frequency of oscillation: 125 kc.

Supplies: 22.5 and 1.45 v; currents depend on R and R_e.

Amplitude of oscillation (peak volts as measured directly):

Amplitude (volts)	*Load Resistor R (ohms)*
1.45	5,400
2.1	11,700
2.3	25,200

Stability (frequency drift in ppm/C°) with input characteristic not shaped (R_F = infinite) and shaped (R_F = 1000 ohms).

R	Drift (unshaped)	Drift (shaped)
5,400	25.0	3.5
11,700	36.0	8.8

Source: C. C. Cheng, RCA Tube Division, Harrison, N. J.; also *Proc. of IRE,* Vol. 44, No. 2, Feb., 1956.

Measurement of

F. K. PRIEBE and **H. D. TANZMAN**
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Fort Monmouth, New Jersey

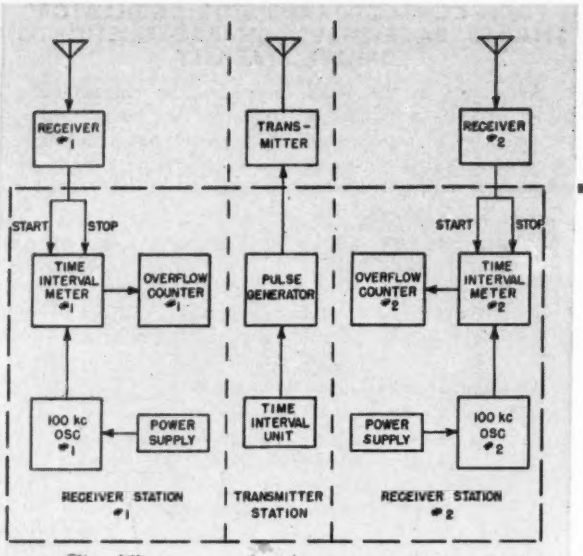


Fig. 1. Block diagram of remote time synchronization system, which can measure the time difference of arrival of r-f signal at 2 widely separated stations within 0.1 microsecond.

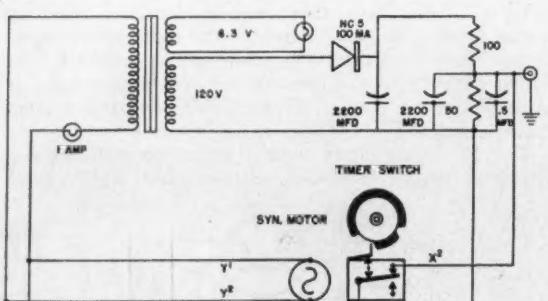


Fig. 2. Interval timer (Industrial Timer, Series CM) to provide 5-minute and 10-minute intervals.

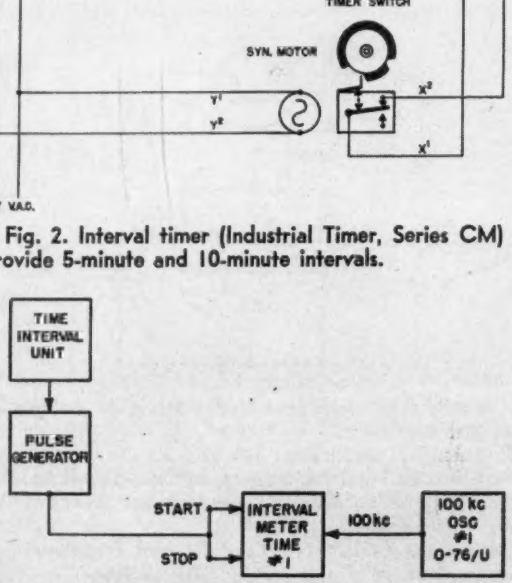


Fig. 3. Circuit used to test repeatability of Time Interval Meter.

Table 1.—Repeatability of Time Interval Unit

Trial	TIM Reading
1	300411434.8
2	300478367.4
3	300394937.5

PRECISION time-interval measurements can be made with existing commercial equipment, such as Time Interval Meters (TIM) or Counters and Timers. However, this equipment is inadequate when it becomes necessary to measure simultaneously the time elapsed between two events at two locations that are separated by a considerable distance. For example, if it is desired that measurements be made with a precision of 0.1 microsecond at two locations separated by a distance of 30 miles, it becomes necessary to have separate oscillators of great accuracy, and this accuracy must be maintained over the period during which measurements are being made. If it is possible to check the frequency of the two oscillators every fifteen minutes (9×10^8 microseconds) and a precision of 0.1 microsecond is required, a stability of 9 parts in 10^9 is necessary because

$$9 \times 10^8 / 0.1 = 9 \times 10^9.$$

A system has been developed which makes it possible to accurately calibrate the two oscillators within 2 parts in 10^8 over a 600-second period and to obtain measurements having 0.1-microsecond accuracy.

The purpose of the timing system is to measure the time difference of the arrival of an electromagnetic signal at two separate stations to an accuracy of $\pm$ 0.1 microsecond. Basically, the system consists of two extremely accurate electronic "stop watches" (TIM's) which are started in synchronism, but stopped separately on the arrival of the signal. The difference between the readings on the TIM's is the desired time difference of arrival.

Prior to the actual timing of the electromagnetic signal, the transmitter sends a series of pulses at ten- and five-minute intervals. The pulses at the beginning and end of the ten-minute interval start and stop, respectively, the TIM at each receiving station. Since both TIM's have operated for the same interval of time, they should display the same reading. However, since each TIM is operated from a separate oscillator (0-76/U), the readings will probably be different. This difference is recorded and used as a correction factor in determining the time difference of arrival. Fig. 1 is a block diagram of the complete system.

Since the stations are separated by approximately 30 miles, it is not possible to operate the two stations from the same oscillator. Therefore, separate oscillators must be used, and the oscillators should not change more than 3.0 parts in 10^9 per second for a 5-minute period (300 usec/0.1 usec). These oscillators should not be calibrated at intervals of less than five minutes because the change is very small for shorter intervals and would be difficult to detect with existing time interval meters. However, if the repetition rate of the measurements is increased, the accuracy required decreases.

SHORT TIME INTERVALS

Problem: How to measure time difference of arrival of r-f signals at two widely separated stations within 0.1 microsecond? Solution: Two time-interval-measurement systems whose counting oscillators are checked at 10-minute intervals. The instrumentation and check procedures are described in detail.

R-F Oscillator, 0-76/U

The source of the precise 100-kc signal in the time measuring system is the crystal-controlled oscillator, which consists of a "GT-cut" temperature-controlled quartz crystal, a driving amplifier for the crystal, an isolating amplifier and a heater oscillator. The oscillator will maintain its frequency to within one part in 10^8 per day (100,000 ± 0.001 cps).

Time Interval Meters

The time interval meters used are modified Hewlett-Packard 524B Frequency Counters and Hewlett-Packard 526B Time Interval Units.

The Model 524B is a precision instrument that automatically measures frequencies to 10 Mc/s and automatically displays its answer in digital form on an eight-place panel indicating system. In addition to making direct measurements of frequency, the Model 524B, when used with Model 526B Time Interval Unit, permits measurements of time intervals from 0.1 microsecond to 10^7 seconds.

Separate "start" and "stop" input channels and their special threshold-selecting controls are contained in the Time Interval Unit.

In the final system, it is desirable that the TIM is disabled so that the display cannot be altered. This is done by modifying the gate section so that the signal gate tube, gate control tube, and the display thyratron will not receive plate voltage when the TIM gate is closed, which then makes it impossible for the TIM to reset or change the displayed reading.

Overflow Counter

The overflow counter consists of three Berkeley Decimal Counting Units, which are direct-reading plug-in electronic counters whose total capacity is 999 pulses, and which resets to 000 on the 1000th pulse.

Pulse Generator

The Teletronics Model PG-200A Pulse Generator is a medium power, precision instrument for generating rectangular waveforms having fast rise and decay time. Wide ranges of pulse duration, amplitude, and recurrance rate are provided. It may be operated self-synchronously or be driven by an external signal of almost any waveform. In either case, it can furnish a fast trigger for synchronizing auxiliary equipment.

Table 2.—HP 524B Comparison Test

No. 1	No. 2	No. 3	No. 4	Time Between Start and Stop Pulses In Seconds	Discrepancy In Counts
88778595	88778596	88778596	88778596	1	1
10035395	10035396	10035396	10035396	100	1
06930184	06930185	06930186	06930186	500	2
22359388	22359389	22359389	22359390	1000	2
96391581	96391582	96391583	96391582	9990	2

Industrial Timer, Series CM

A timer (Fig. 2) was assembled in order to meet the requirements for providing the following time sequences:

Counting time:	10 minutes
Reset and "off" time:	5 "
Counting time:	10 "

A synchronous motor-driven cam actuates a Microswitch at the end of 5- and 10-minute intervals. The switch, when closed, shorts out a 50-ohm resistor. The short across the resistor triggers the pulse generator; the capacitor prevents arcing so that malfunctioning of the pulse generator due to multiple pulses does not occur.

Repeatability Test of Time Interval Unit

Fig. 3 is a block diagram indicating the circuit used in this test. The time interval unit generates pulses which "start" and "stop" the TIM. The period that the TIM is on depends on the time interval unit. The precision of the time interval unit is better than 1 part in 300, which is adequate for the purpose of establishing the 5-minute and 10-minute basic intervals. Table 1 indicates the repeatability of this time interval unit.

Test of Time Interval Meters

During all tests made it was found that all HP Type 524B TIM's operated well within the required limits. At no time did errors occur that could be traced to the TIM's. A series of tests were designed to ascertain the reliability of the TIM's. Fig. 4 is a block diagram of this test system. Table 2 shows the performance of all four TIM's when operated from one Oscillator 0-76/U as the external 100-kc standard. The "start" and "stop" gates were operated manually.

Test of 100-kc Oscillators

The 100-kc oscillators were connected as in Fig. 5, and aged for thirty days. This system allows for a continuous recording of the beat note resulting from heating the reference standard against a 100-kc oscillator. During the aging period, the frequencies of all the oscillators were periodically adjusted to zero beat with the standard. The heater control resistors in the coarse thermostat circuit were constantly adjusted to keep the reading on the heater current meter at center scale. As a reference

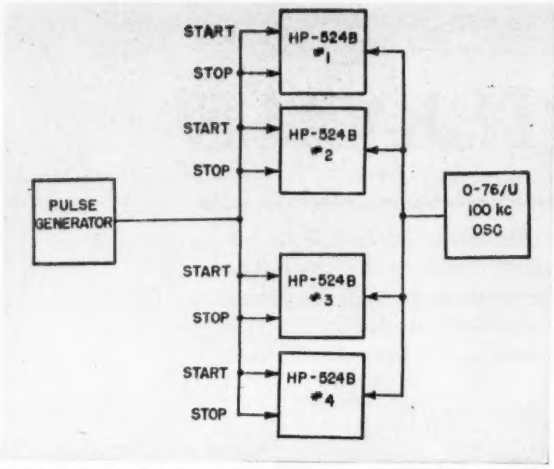


Fig. 4. Block diagram of comparison test circuit for testing HP 524B Time Interval Meters.

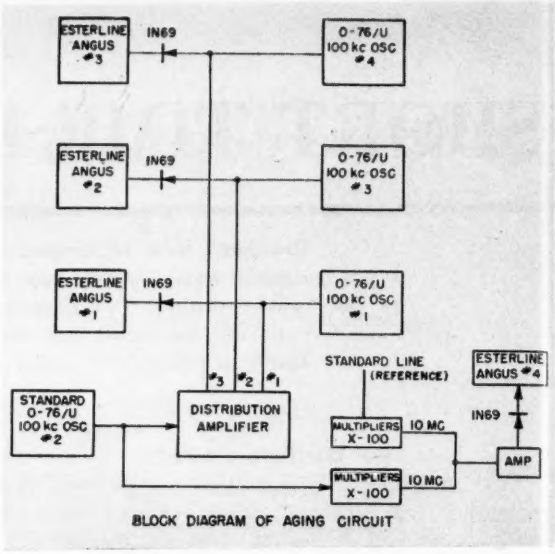


Fig. 5. Beat rate between standard oscillator (lower left) and other 100-kc oscillators is recorded to test oscillators for drift.

standard for this test, the master oscillator feeding the 100-kc line throughout the laboratories was used. This oscillator has been aged for over 3 years; therefore, its drift rate is very low.

At the end of the aging period a test circuit, as shown in Fig. 6, was set up. One oscillator was connected to a precision time interval unit, which generates one pulse every 1000 seconds, and the output of this unit was used to start and stop the time interval meter. The second oscillator was used to supply the 100 kc necessary for the operation of the meter. The two oscillators were set to the exact frequency at the beginning of the test. If the oscillator which starts and stops the TIM decreases in frequency, the reading on the TIM increases. This information was plotted and indicated the relation between the two oscillators; a relative drift rate of 10 parts in 10^8 per hour was thus indicated.

Final Test

The final test circuit, which simulates the actual operating conditions, is shown in Fig. 7. The circuit operates in the following manner: The Pulse Generator PG-200A is triggered from a precision time-interval generator and feeds a pulse to start TIM's 1, 2, and 3.

After starting TIM's 1, 2, and 3, switches S_1 and S_2 are closed. The succeeding signal pulse from the precision time base generator triggers the pulse generator again; this pulse stops TIM's 1 and 2 and starts TIM 4. This same pulse is delayed by a pulse-delay generator and stops TIM's 3 and 4 after a delay of Δt.

Note that two individual Time Interval Measuring Systems are used in the final test. Time Interval Meter 1 is started and stopped by two successive pulses and constitutes, with its Oscillator 0-76/U, an independent system. TIM 3 is started by a pulse and stopped by a second pulse delayed by the delaying network. It has its own Oscillator 0-76/U and therefore represents a second Time Interval Measuring System which, except for the starting circuit, is independent of the first one.

Assume that the two Time Interval Measuring Systems have been started by a calibration pulse; then any following pulse will stop both systems at different times, depending on the delay.

Comparing Fig. 1 with Fig. 8, it is seen that TIM 3 plus the delay in Fig. 8 is equivalent to Receiver Station 1 in Fig. 1. (The delay in Fig. 1 is represented by the transmission medium). In Fig. 8, TIM 1 is the same as Receiver Station 2 in Fig. 1 if it is located at the transmitter.

The difference in readings between TIM 1 and TIM 2 is due to the relative difference in oscillator frequency.

The difference between TIM 1 and TIM 3 in Fig. 8 is the difference between TIM 1 and TIM 2 plus the delay. The final performance data are listed in Table 3.

TIM 1 plus TIM 4 should equal TIM 3. Table 3 shows that it does within 0.2, which is entirely permissible, since one TIM can be 0.1 high and the other 0.1 low.

In the arrangement in Fig. 1, calibrations of the oscillators can be made prior to and following actual time measurements by the transmission of precise pulses derived from a reference oscillator and transmitted by the transmitter located in the center of Fig. 1. During the actual time measurement, Receivers 1 and 2 in Fig. 1 are tuned to a frequency that is different from the calibration frequency and no calibration is obtained during the actual measurement. A correction can be used for the actual measurement based on the readings of TIM 1 and TIM 2 just prior to the actual time measurement (as determined by the calibration before the measurement).

Table 3.—Final Performance Test Data

Trial No.	Time 1 (usec)	Time 2 (usec)	Time 3 (usec)	Delay Time 4 (usec)	3—2 (usec)	Correction (A) 2—1
1	1000124050.0	1000124081.4	1000124198.1	116.9	116.7	31.4
2	1000008237.0	1000008269.1	1000008386.0	116.9	116.9	32.1
3	1000001865.0	1000001998.0	1000002114.7	116.9	116.7	33.0
4	1000001929.2	1000001961.6	1000002078.3	116.8	116.7	32.4
5	1000001991.1	1000002023.7	1000002166.9	116.9	116.8	32.6
6	1000002017.2	1000002050.1	1000002191.2	116.9	116.8	32.9
7	1000001963.7	1000002074.4	1000002191.2	116.9	116.8	110.7

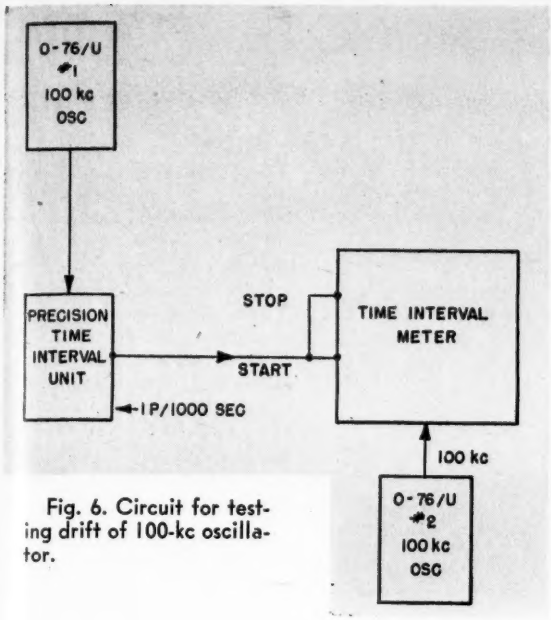


Fig. 6. Circuit for testing drift of 100-kc oscillator.

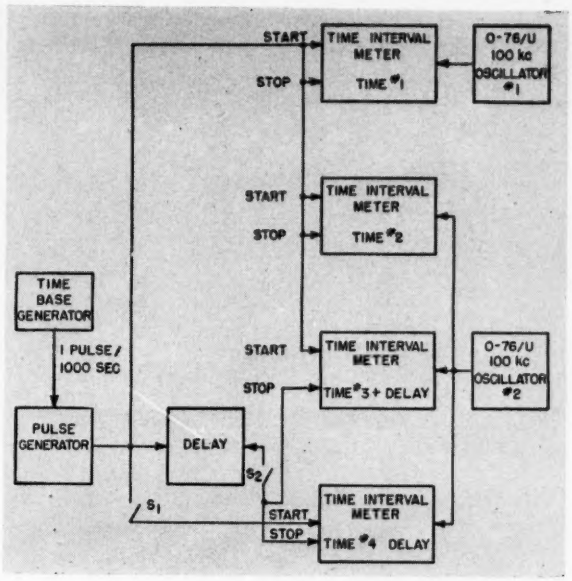


Fig. 7. Block diagram of final test circuit.

Another correction may also be used based on the relative difference of the intervals as determined by the system shown in Fig. 8.

Fig. 8 and Table 3 show a portion of the results of the final test for a 24-hour period. Readings were taken at 2000-sec intervals. The effect of the random variations has been eliminated by forming the best estimate of the average line in accordance with statistical procedures.

Also shown in Fig. 8 are two boundaries which represent the 90% confidence limits. These confidence limits indicate the range of variation and the best statistical estimate the average line can have in order that no more than 10% of the points fall outside these limits.

Fig. 8 and Table 3 show four extremely high values for the difference between the readings of TIM's 1 and 2. These values, ranging from 51.2 to 129.1 are obviously in error. Since the difference between TIM 3 and TIM 2 is normal, the error has to be either with TIM 1 or Oscillator 0-76/U, No. 1.

Later it was determined that the error in readings was due to noise superimposed on the signal.

Conclusions

The final test reveals two groups of errors; one which is extremely large (129.1 usec max) and one comparatively small (2.8 usec max). The large error is caused by faulty triggering of the TIM. The smaller error is due to erratic operation of Oscillator 0-76/U, which changes suddenly due to variations in plate, heater and filament voltages. The control circuits for the heaters were also a source of trouble. Many users of the Oscillator 0-76/U have modified their units to eliminate these sources of trouble.

Subsequent investigations revealed that at least one oscillator has been produced which is superior in many respects to Oscillator 0-76/U. The unit referred to was developed by the Radio Laboratories of the British Post Office.

The present rate of count for Time Interval Meters is 10 Mc/s. Evidence exists that it is entirely possible to design and construct a high-speed TIM that will operate at a rate of 100 Mc/s. The use of an oscillator with a stability of one part in 10^{10} and a time interval meter with a counting rate of 100 Mc/s could greatly increase the accuracy of the time interval measurements.

The system as described worked satisfactorally for a period of several weeks.

Acknowledgments

The authors wish to express their appreciation to Dr. G. K. Guttwein for his valuable suggestions concerning this report and for his advice in consultations during the development of the system. Gratitude is also extended to Messrs. Charles Miller and William Scott.

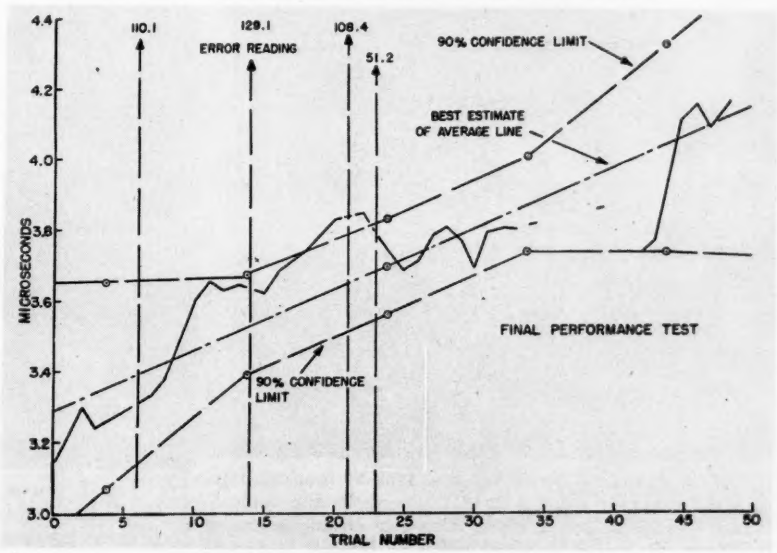


Fig. 8. Final performance test.

Fig. 1. Two-story control house for one open-hearth furnace. The top room houses all the electrical controls for furnace doors, reversing valves, slag buggies, etc. The first floor houses the control panel and most of the combustion mechanism which is located at the rear of the panel board. Both rooms are steam heated and pressurized to keep dust infiltration at a minimum.

Iron & Steel ⇄

YOU met Bob Lambert, Superintendent of the Steam Efficiency and Combustion Dept., J&L Pittsburgh Works Division, on page 1947. Here are typical instrument activities at his plant. His instrument Repairmen attend courses on instrumentation conducted by Hagan, Leeds & Northrup, Askania, and Foxboro. Classes are also held by the Jones & Laughlin Steel Corporation in conjunction with the Mineral Industries Extension Services of the Pennsylvania State University, covering Combustion and Instrumentation.

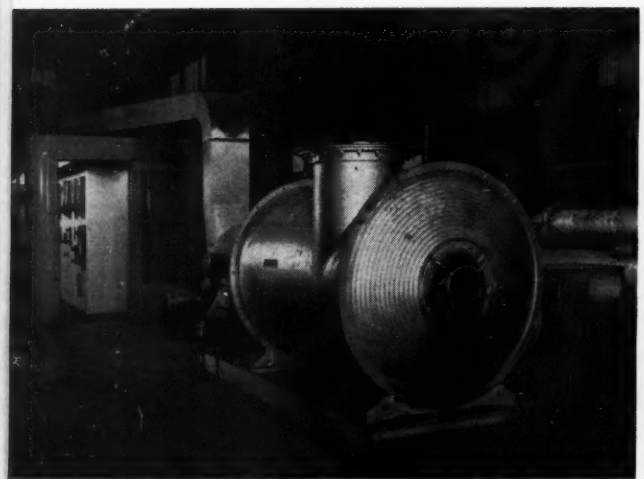


Fig. 2. A control house for one bank of four soaking pits has a blower which is used to pressurize the control house through ceiling ducts to keep dust infiltration to a minimum. One of three combustion air blowers is shown in foreground.

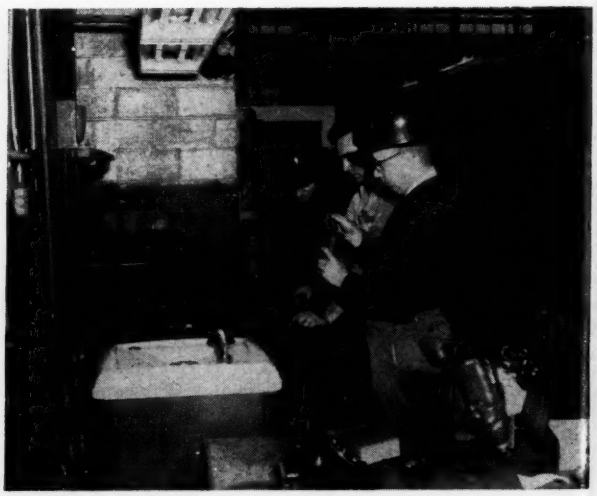


Fig. 3. An improved open-hearth bath thermocouple which was designed and constructed by the Combustion Division personnel.

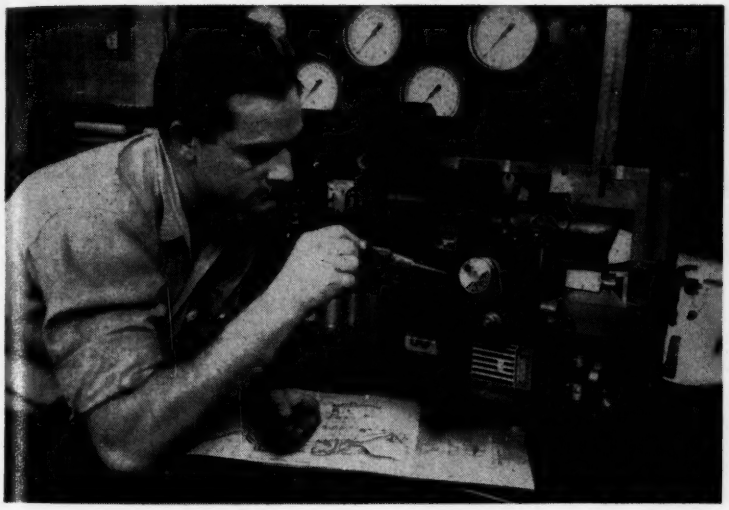


Fig. 4. Instrument Repairman adjusts a temperature recorder controller in the Instrument Repair Shop.

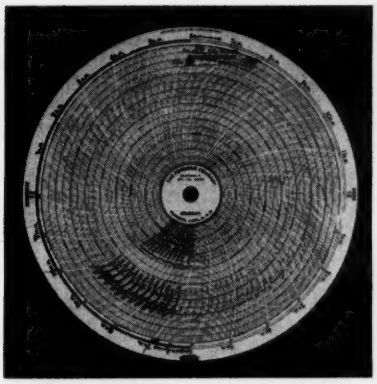


Fig. 7. Record from open hearth temperature control instrument, a six point circular chart recorder. The lower continuous line depicts the temperature of steam for atomization. The upper continuous line around the chart represents the stack temperature. (This is from a thermocouple just after the main stack damper and it usually records at about 1250°F.) The crisscross lines are recorded from thermocouples and represent temperatures in the flue outlets.

Instrumentation

Fig. 8. Primary element for open hearth roof temperature control consists of a "Rayotube" on the roof of the furnace.

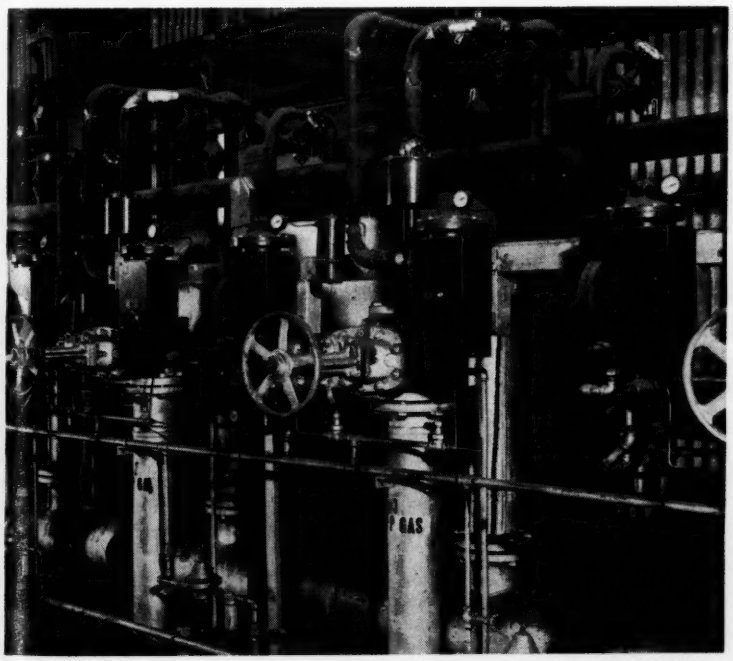


Fig. 5. Gas and fuel oil transmitters and valves for one bank of soaking pits are mounted on the floor level behind the control houses. A transmitter is installed in the fuel lines to each pit and converts the fuel measurement to an air impulse signal that is imposed on the fuel measuring unit. No fuel lines enter the control houses.

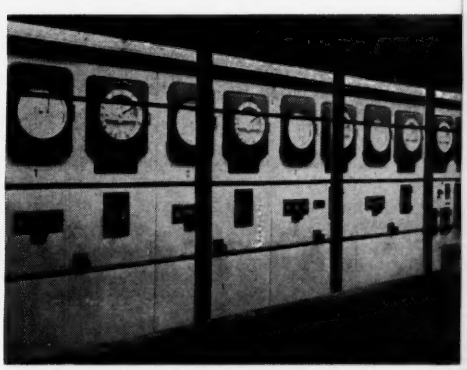


Fig. 6. Front view of a control house for one bank of soaking pits.

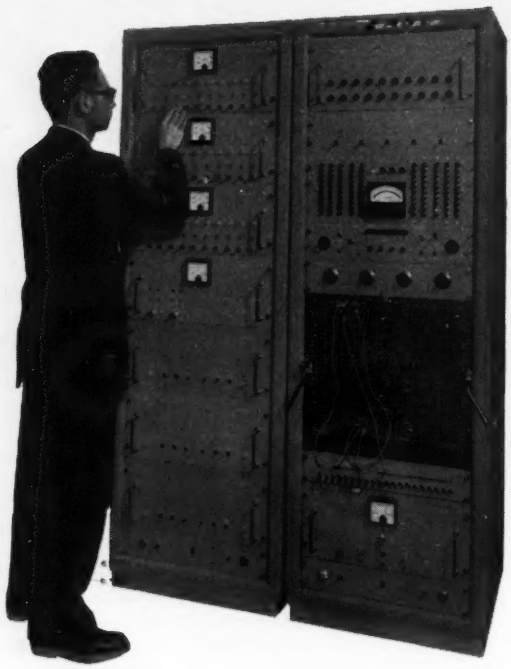


Fig. 1. Basic EASE Computer satisfies need for small, inexpensive machine but can be expanded as the process control engineer's problems become more complex. This unit contains 30 amplifiers. At left is the Model 1185; at right, Model 1187. (EASE is a registered trademark of Berkeley Division, Beckman Instruments, Inc.)

Process Control and the

The analog computer can be used both to design the control system and to control the system. Here are the elements of the analog computer and examples of how the computer can be used in the process industries as either a basic analyzing device or as a controller.

ANALOG COMPUTERS and analog techniques are finding their place in process control as the demand for flexible and diverse control equipment grows. Analog-type electronic components have established a record of high reliability. As more transducers are developed and technical personnel trained, these components are being applied widely. Such rapid acceptance is due largely to the versatility, accuracy, and low cost of the electronic approach. These and other advantages become apparent as the techniques are understood.

The concept of feedback control has been used for many years in the field of electronics. In general, feedback techniques can be described as follows:

1. Compare the actual value of the controlled variable to the desired value (error detector or comparator).
2. Feed the difference (error) into an amplifier.
3. Feed the amplified error signal into a controller which drives the actuator.
4. The actuator operates on the process to reduce the original error.

Presented at the Computer Clinic, Second International Automation exposition, Chicago, Nov. 14-17, 1955.

Advantages of Feedback

The closed-loop controlled process is essentially the same as conventional negative feedback as used in the electronics industry and offers the same advantages, as illustrated by comparison with a system without feedback (an open-loop system). Fig. 3 shows an amplifier (represented by a triangle) with input e_i, output e_o, an input network, and a feedback network. Regardless of the input signal to the amplifier, the output should be A times its input (gain of A). This may be an electronic amplifier, it may be a position indicator (angular or linear), or it may be a pressure system. The same rules apply.

If no feedback is used, it is found that as the gain A becomes greater than unity, accuracy is increasingly difficult to maintain because of vacuum-tube characteristics, gear backlash, etc. Consequently, for any amplifier with a gain of 50 or more, accuracies of the order of $\pm$ 1% are difficult to achieve, and accuracies of the order of 0.1% or better are nearly impossible. However, when feedback is used to close the loop, as shown in Fig. 3, it is found that as the gain A increases, instability shrinks

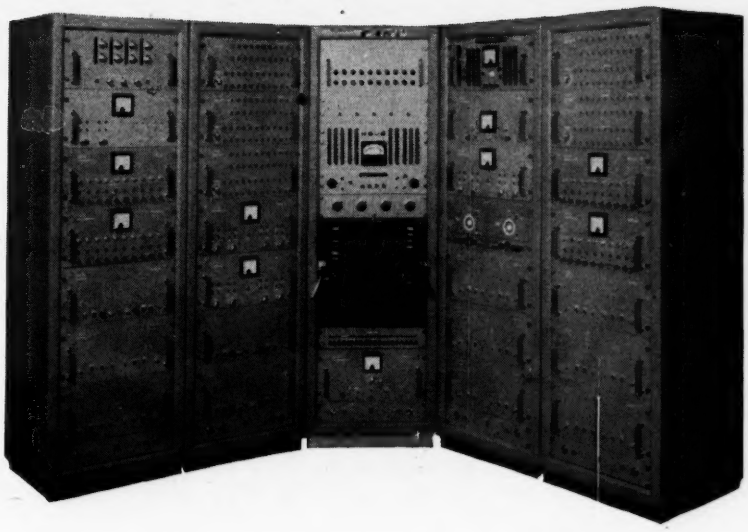


Fig. 2. The heart of this expanded EASE Computer is the patchboard in the center cabinet (Model 1187). The two cabinets at either end, Model 1185s, house 20 amplifiers each and their power supplies. The cabinet at right of the patchboard contains electronic and servomultipliers. At left of the board is another Model 1185 housing electronic function multipliers.

Analog Computer

JOSEPH L. HUSSEY
Berkeley Division
Beckman Instruments, Inc.

and accuracy can be achieved more easily. With feedback, accuracies of 0.01% and better are attainable.

Every closed-loop control system is a system that uses feedback. The analog computer is a device that permits the system designer or control engineer to determine exactly how much feedback and what type of feedback he should use in order to achieve optimum control of his system.

Elements in the Analog Computer

A brief explanation of the analog computer and how it functions will dispel any fears or feelings of mysticism that process engineers may have about these devices.

Analog techniques generally use the following building blocks:

1. D-C negative-feedback amplifiers
2. Attenuators
3. Multipliers
4. Arbitrary-function generators
5. Combinations and special forms of all the above.

D-c amplifiers (represented by the triangle in Fig. 3) can be made to perform as summing devices, inverters, subtractors, integrators, or differentiators by suitable choice of input and feedback networks. (Inverting is defined as changing the voltage polarity.)

Attenuators (precision potentiometers) can be used in conjunction with the d-c amplifiers to allow continuous control over the gains of the various amplifiers, permitting different modes of operation. These controls can be mounted at a central control console connected to the system only by cables. The result: efficient control over the process by a single operator in minimum space.

Multipliers are used to form the products of two voltages. These can be all-electronic or electromechanical in nature.

Function generators are used to generate a voltage which will be an arbitrary function of an applied voltage.

Typical problems require use of computers with anywhere from 10 to several hundreds of amplifiers, and from 0 to 20 or 50 multipliers, and other equipment in this same ratio.

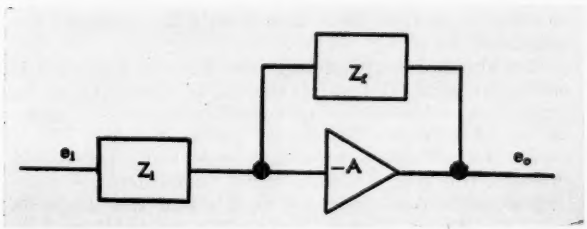


Fig. 3. Closed-loop system comprises an amplifier with feedback from the output to the input.

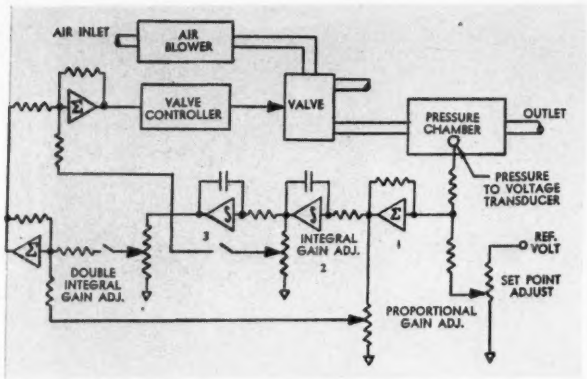


Fig. 4. Three summing amplifiers and two integrating amplifiers are used here to establiish the amounts of proportional, integral, and double-integral control actions required for optimum control of valve.

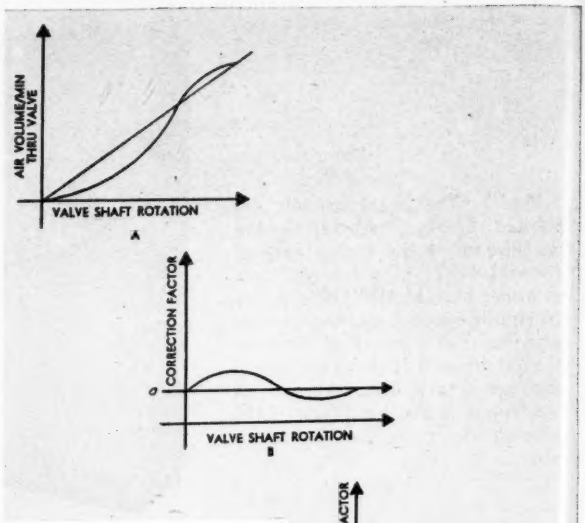


Fig. 5 (A) Characteristic of control valve of Fig. 4, showing nonlinearity. (B) Curve of nonlinearity of valve —i.e., departure from the desired straight line. (C) Curve generated by the function generator to approximate curve (B).

The Patchbay

This equipment, in order to be tied together to simulate the desired system, must have some means of connection. This interconnection system is the heart of the analog computer. It is usually a patchbay system with a removable patchboard. Through the use of the patchboard, all of the components (amplifiers, multipliers, etc.) can be wired together in such a way that they will be the electronic analog for the chemical, mechanical, or hydraulic system under study.

Most high-quality analog computers available today have been designed on a module system. This allows the user to start with a small machine (one patchboard and 10, 20, or 30 amplifiers and associated equipment) and later, as his understanding of the problem grows, to add more equipment to this machine so that he can handle even his largest problem (see Figs. 1 and 2).

Function Generators

The cabinet at the left of the patchboard in Fig. 2 (Model 1185) contains electronic function generators. These are the units which allow the generation of any arbitrary function of the input voltage. The function generators manufactured by Berkeley Division, Beckman Instruments, are of three types; all are based on the principle of approximating the desired characteristic by a series of straight lines. The straight-line segments are generated by use of diodes.

The simplest and least expensive function-generator is set up by hand. It requires the use of two external d-c amplifiers, reference voltages, and attenuators in order to set up the desired function.

The second unit is somewhat more costly but is still manual. However, it has its own d-c amplifiers and associated calibration circuit. It is this unit that finds its place in process control because it is somewhat simpler to set up than the first model. Even though it contains its own calibrating circuits, it is not particularly adaptable to repeated set up. However, its use as a linearizing element in a process controller does not require that it be set up repeatedly; the engineer may set the unit up once and leave it for a considerable length of time. As such, this unit—the Model 1073—becomes of particular interest to the control engineer.

The third unit—the Model 1071—employs a servo system in conjunction with a pushbutton control panel in order to set up the desired transfer characteristic. The use of a pushbutton setup allows much faster calibration. For this reason, if the control engineer must often change the transfer characteristic under study, the Model 1071 should be used. The time saved in setup more than offsets the higher initial cost.

When all of this equipment is tied together and the control engineer has patched in his particular problem, he can investigate the entire system being studied or any part of it; also, at any arbitrary time in the process of problem solution, he can stop the machine to examine the behavior of any component within the system. This holding feature allows a safety factor for the engineer.

Scaling and Overload

All critical circuits contain overload detector circuitry connected in such a way that, at the discretion of the operator, the machine may be automatically switched into the hold position if any amplifier or multiplier or function generator within the system indicates an overload. By this technique the engineer is given warning that the problem under study has not been scaled properly. He can then rescale the problem.

Patchboard Capacity

The amount of equipment that can be patched in a given computer installation is determined primarily by the amount of equipment that can be interconnected at one patchboard and by the number of patchboards that

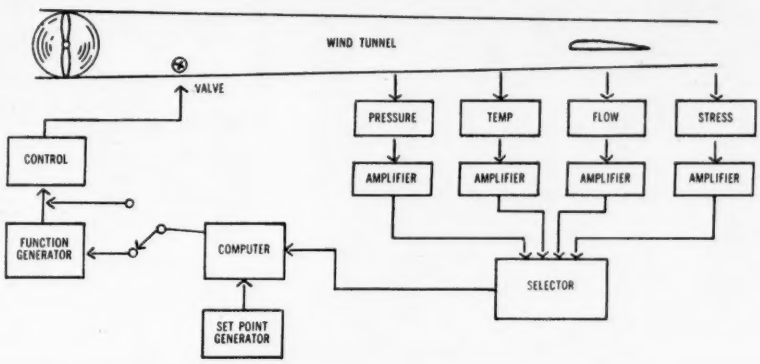


Fig. 6. Analog computer receives data from several variables and, with function generator, establishes a program based on conditions within the process.

may be operated with one another. The patchboard provided on the Model 1032 provides access to 50 d-c amplifiers, 16 single-product electronic multipliers, 10 arbitrary-function generators, and 6 servos which can each produce 6 products. It also provides access to 100 coefficient potentiometers. The potentiometers of this system are set by remote control through the use of a pushbutton system and a servo control.

Of the 50 amplifiers provided for by this patching system, 20 may be summing amplifiers, 20 may be integrators, and 10 are used as inverters or general-purpose amplifiers. Each integrator has associated with it a switch which will connect it either as an integrator times unity or as an integrator times 10 (the switch will change the feedback capacitor from 1 microfarad to 0.1 microfarad). The patchboard itself is removable and can be connected by the engineer at his desk. This allows another engineer to be using the machine while other problems are being wired.

The patchboards used with the EASE computer have the unique feature that as they use one hole of the patchbay, they create another one. That is, the connector is both male and female. Accordingly, a beginner does not have to worry about the manner in which he patches a given problem; he can never run out of terminals. In addition to the equipment described, there is available at this patchbay equipment necessary for the control of the machine and for proper simulation of some nonlinearities. This includes diodes for functions such as backlash and friction. It also includes reference voltages, bias voltages, and certain switching functions.

Experience has shown that at least three or four of these patchbay units can be interconnected to allow operation of 100 to 300 d-c amplifiers and their associated equipment. From this, it is seen that the computer of Fig. 2 can be expanded as needed. This, of course, has required considerable attention to such factors as the grounding system, power supply, and interaction. The design of the computers is such that there is no limit to the number of patchbays that can be tied together.

A Pressure Control System

To illustrate the flexibility of simulation techniques, consider a pressure control system that might require, for optimum control, double integral control plus proportional control. Fig. 4 shows the system.

The designer for such a control system must determine two factors: (1) compensation necessary (if any) for the controller and process characteristics so that uniform accuracy is maintained over the complete operating range, and (2) which combinations of proportional, derivative, integral, and double integral gains will give proper performance. These gains and the ratios between them will be different for each system.

The parameters can be determined by long-hand calculations, by "cut and try" approach, or by simulation techniques. Simulation can save considerable time and money in the design phase, as well as provide experience for the electronic systems to follow. (Analysis of operating plants by simulation can also point the way to savings via change in control system, or process equipment, or both.)

In Fig. 4, three summing amplifiers and two integrating amplifiers are used to simulate the controller. The potentiometers and switches can be located remotely from the remainder of the equipment. The potentiometers indicated allow four types of control:

1. proportional (amplifier 1)
2. proportional + integral (amplifiers 1 and 2)
3. proportional + integral + double integral (amplifiers 1, 2, and 3)
4. proportional + double integral (amplifiers 1 and 3).

The switches allow selection of the desired control, while the potentiometers allow the relative gains to be adjusted to the desired values. The system can be modified for various other types of control, including derivative (anticipatory) control. With additional equipment, temperature, humidity, etc. could also be controlled.

All the electronic components in the system have high speed of response; the limiting factor will be the speed of response of the valve controlling the air flow.

Characterization by Arbitrary-Function Generator

To further complicate the preceding example, assume that is it desired to regulate the air pressure of the chamber over a wide range of pressures. To maintain equivalent control accuracies at high pressures as at low pressures requires that loop gain stay the same. The valve, however, if it is the rotating type, has a nonlinear characteristic which must be compensated. This linearization of a nonlinear element is easily accomplished electronically with an arbitrary-function generator.

The function generator produces an output voltage which will maintain a predetermined relation to the input voltage. This can be accomplished by biased diode circuits which change the gain of the unit as a function of the input voltage. Essentially, this system approximates the desired gain characteristic with a series of straight line segments. The slopes and intersections of these line

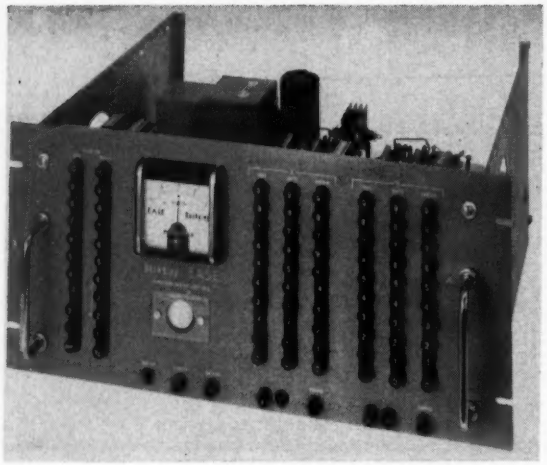


Fig. 7. Model 1032 function generator.

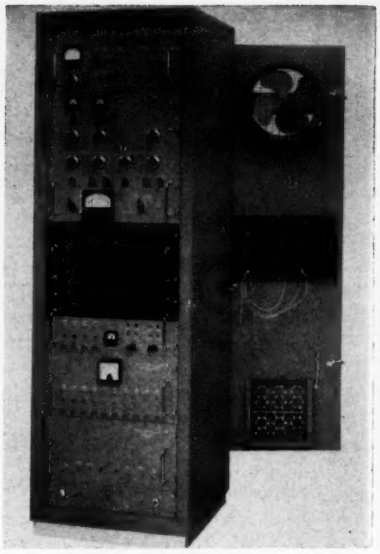


Fig. 8. A control system, the first of its kind, for a high-speed wind tunnel.

segments are continuously adjustable in most commercial units.

To illustrate the use of an arbitrary function generator, let us linearize the characteristic of the valve of Fig. 4. This characteristic is shown in Fig. 5a. The departure from a straight line (nonlinearity) is plotted in Fig. 5b. A function generator then can be adjusted to approximate this correction curve (Fig. 5c). If this function generator is then used in the control loop, the nonlinear destabilizing effect of the valve can be eliminated.

Wind-Tunnel Computer Controller

The previous example showed how the analog computer can be used to analyze a control situation. The computer can be used also to perform the control actions required in situations of great complexity.

Fig. 6 shows an analog computer incorporated within the control loop so as to control the process in accordance with a program based on the pressure, temperature, flow, and stress variables in a wind tunnel. Data on all these variables are extracted by transducers, amplified, and transmitted to the analog computer. The program for the entire system is established by a function generator. The inputs are linearized and time compensated to prevent oscillation. The output of the computer actuates the control devices which operate the wind tunnel.

Fig. 7 shows a Model 1032 function generator which was used as the function generator in Fig. 6 to program the entire operation. A general-purpose EASE computer was used as the computer in the system. The advantages gained were rapid automatic correction of conditions based on results, optimization of the process, and accurate control of the process over a short time interval.

Fig. 8 shows the first closed-loop control system using these analog techniques for control of pressure and temperature conditions in a high-speed wind tunnel. It will be used to test jet engine operation at Arnold Engineering Development Center, Tullahoma, Tenn.

Mating the Fields of Computing and Process Control

At this point, the reader may remark, "What you say here is fine, but the fact remains that we who have the problems do not understand electronic techniques, and you who have the electronic techniques do not understand our problems," and we must all agree. This problem is currently being solved by each of us learning more about the other's techniques.

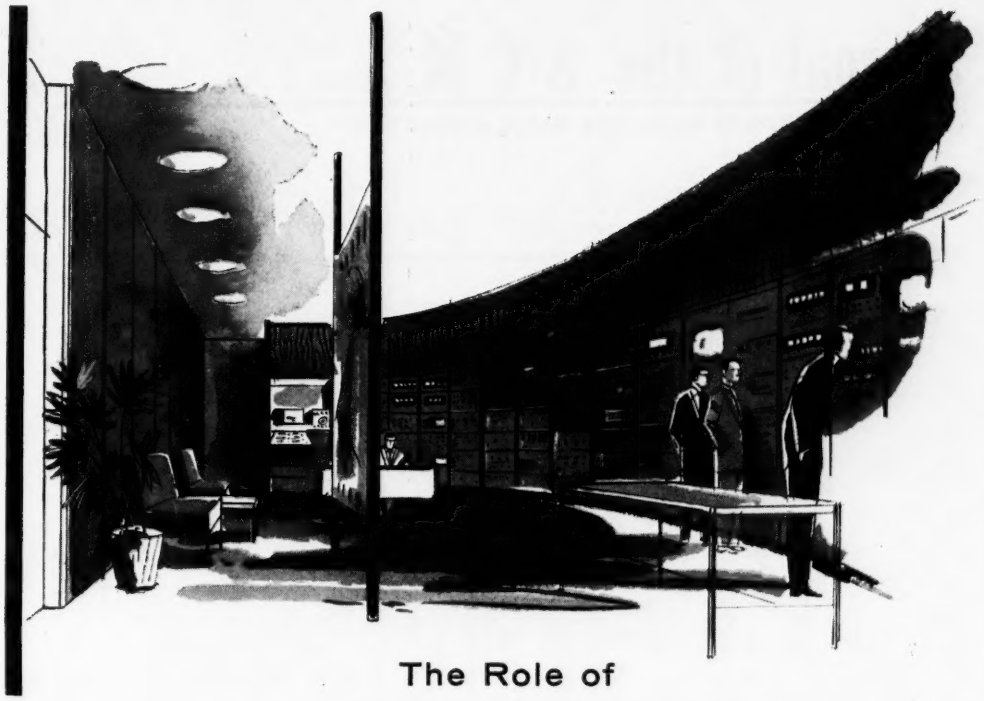
Manufacturers of computing equipment must expand and explore new fields, such as the field of process control. To do this, they are willing to expend considerable money to train people in the field of process control. Many large computer companies have organized a staff of trained engineers who will spend the time necessary to study the problems of the process engineer.

In addition, qualified consulting engineers and engineering groups are organizing all over the country. These consulting companies have people who are well versed in the field of electronic techniques and who also understand the process engineer's problems. These people will, for a fee, help the process engineer to apply electronic equipment to his problem. From this, it would seem that the people in the electronic field are doing their part to help the control engineer adapt electronic equipment to his problem.

On the other hand, the process engineer is currently spending a great deal of time in familiarizing himself with electronic equipment. There are many large companies, particularly in the petroleum fields, who have groups of engineers whose prime aim is to apply electronic controlling techniques and computer techniques to their particular processes. The two groups, working toward a common goal, will eventually solve the problem of applying electronic computers to process problems.

In general, it would seem simpler to have the process control engineer learn the electronic techniques rather than vice-versa, and there is much for the process man to gain. This is particularly true when he can use electronic equipment to solve the mathematics of his problem and gain a better understanding of his problem. In fact, it is this understanding and familiarity with both systems (that is, both the electronic and the controlled system) that makes him much more valuable to his company. As he works with the problem in the machine, he becomes much more aware of which factors within his own system which give rise to poor performance.

Editor's Note: Classes on analog computers are available to all process men at the Third International Automation Exposition, New York, Nov. 26-30.



R-W Data Reduction Center now under construction

Denver plant now under construction will augment the Division's manufacturing facilities

Instrumentation development

The Role of INSTRUMENTATION and TEST EQUIPMENT in Systems Work

The complexity of modern weapons systems, as well as certain electronics systems for industrial applications, is such that the design and installation of instrumentation for obtaining experimental test data and converting it into usable forms has become a highly specialized field of technology.

A closely related field is that of test equipment needed for the adjustment and maintenance of the end-product hardware, both in the manufacturing plant and in the field. Experience has shown that the effectiveness of a major new system frequently falls short of its potentialities because of inadequate attention to this essential supporting activity.

In The Ramo-Wooldridge Corporation, the Electronic Instrumentation Division has the mission of bringing to the areas of instrumentation and test equipment a level of competence that is adequate to deal with the often very difficult problems that need to be solved in such work.

Assignments undertaken for a number of government and industrial customers include such diverse projects as flight instrumentation, data reduction equipment, and transistorized power supplies. Another important project of this Division is that of providing The Ramo-Wooldridge Data Reduction Center with a system and arrangement of equipment carefully designed to meet the company's specific requirements. Also in progress is the development and fabrication of field test equipment for an electronic system R-W now has in early production.

A unique and important feature has been incorporated into the services offered by the Electronic Instrumentation Division. For each project, an advisory committee is established composed of experienced systems engineers from other divisions of the company. By periodic reviews, such advisory committees assure that the development work of the Electronic Instrumentation Division takes into account the very special and often not well understood needs which arise in systems work.

Further information about this R-W activity can be obtained by writing to the Director, Electronic Instrumentation Division.

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Journal of the S C M A . . .

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Economic Aspects of

PROCESS CONTROL

Practical examples show the dramatic cost savings possible via the integrated data-handling-computing-controlling control center. Even greater benefits now await fuller cost analyses. The pneumatics vs electronics cost situation is discussed in detail.

WILLIAM C. GARDNER
and
JOHN E. LEARY
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YOU have read and heard a great deal about automation. Much of the discussion has centered around the effects of automation on employment. Some view automation as a monster that will throw people out of work; others credit every productive advancement to automation alone. Neither extreme view is true; automation is only one of the many factors responsible for the state of our economy. The transition from semi-manual to completely automatic operations will be a gradual evolution—as the employee is relieved of menial and repetitious operations, he can be upgraded into work requiring judgement and higher skills.

The concept of the push-button plant has been highly publicized. Indeed, there are cases of high degrees of "humanless" operations. However, when the term automation is applied to a process, it frequently implies that all decisions must be made by machines.

Machines required to make a variety of decisions must necessarily be complex. The costs of such intricately programmed machines will be prohibitive in highly competitive businesses. In other fields, such as missile-guidance systems, there is no alternative other than complete automatic control, and other factors are given more consideration than economics. In the process, however, the complete elimination of the human operator does not appear to be economically feasible in the immediate future—because unless the problem is highly repetitive, human reasoning is costly to replace.

Prepared for the Conference on Instrumentation and Control in the Process Industries, Sponsored by Armour Research Foundation, January 25-26, 1956.

November Meeting: *Thursday, the 15th, Rio Hondo Country Club, Downey, Calif.*

Feature: *Robert Bryan, Air Pollution Control District of Los Angeles County, will present a talk on "Air Pollution Monitoring Instrumentation."*

Investment in Instrumentation

Evidence of the increasing role played by instrumentation is shown by the increase in instrument sales compared to plant investment. In the past few years, American industry has invested over three times as much in yearly plant expansion as in 1930. But the yearly investment in instrumentation has been ten times that of 1930. During this same period, while the total plant investment per unit of output has fallen off slightly, production has increased greatly, and the man-hours per unit of output have declined rapidly. Because of this relationship, economists predict that we eventually will have a 32-hour work week.

In recent years the cost of instruments has ranged from 5% to 15% of process-equipment costs. This wide range may be explained in two ways—(1) instrument control is inherently less costly for some processes than others, and (2) in many cases we are not making full use of recent developments in instrumentation. In plant design, more consideration should be given to the available dynamic-response and accuracy of the control systems. Instruments with faster response time will enable us to reduce surge capacities and consequently the size of process equipment.

During the next ten years, 800,000 new productive workers will enter the process-industries each year. Industry will invest an average of $10,000 per worker for production facilities. Each year, instrumentation alone will cost from $60 to $500 for each worker in these industries. Let's see how this money will be spent.

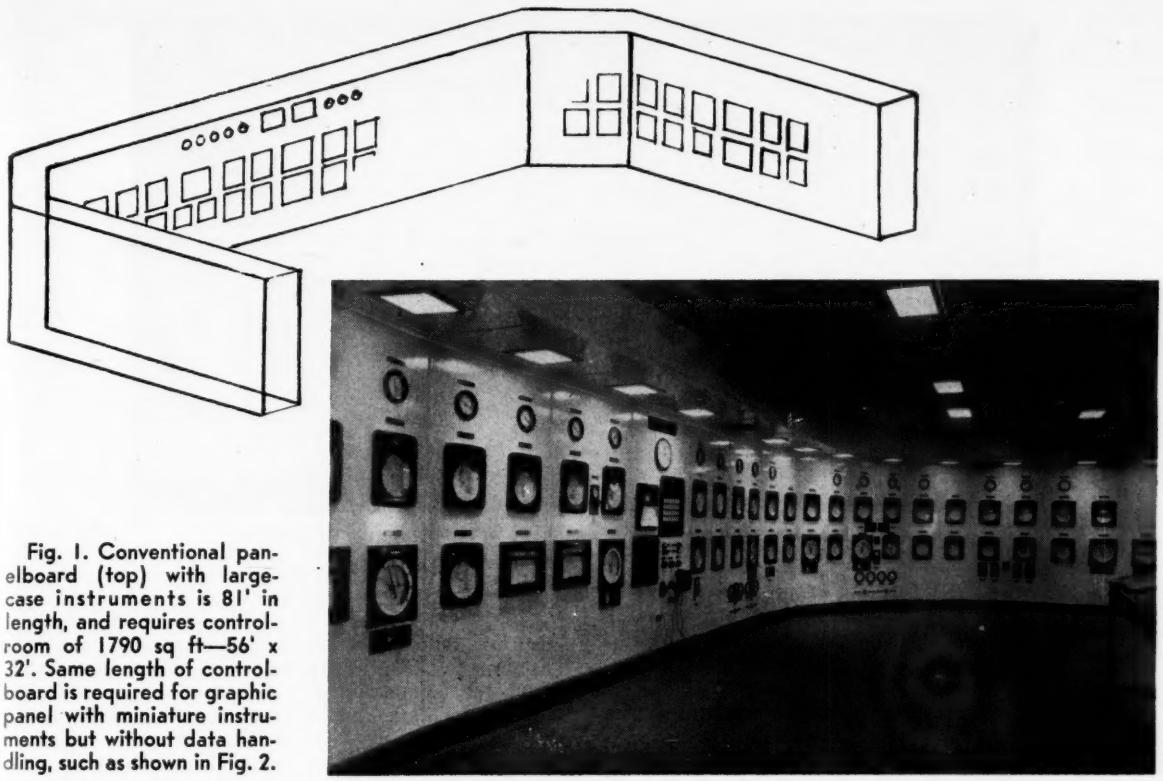

Fig. 1. Conventional panelboard (top) with large-case instruments is 81' in length, and requires control-room of 1790 sq ft—56' x 32'. Same length of control-board is required for graphic panel with miniature instruments but without data handling, such as shown in Fig. 2.

Electronics Versus Pneumatics

Although the use of electronic systems is increasing, pneumatic systems have certain advantages and are not yet ready to be classed with the horse and buggy. Most pneumatic instruments use a standard 3-to-15 psi signal; the user does not tie himself to any one make by using pneumatics.

Signal Standardization. In contrast, electronic manufacturers use several incompatible signals—a-c and d-c signals with response to voltage, current, and frequency. Hence once an instrument supplier is selected, the use of other makes becomes impractical; additional components must be used to convert from one manufacturer's signal to another. There is a need for agreement among suppliers and users on a standard. The best signal can be determined only after actual operating experience has been gained with the equipment now available.

Transmission Costs. A complete comparison of pneumatics versus electronics must include the cost of signal-transmission between instruments. Electronic transmission uses standard wiring and conduit methods. However, pneumatics affords several alternatives—either single-tube or multi-tube cables of metal or plastic. While wiring costs are fairly uniform, tubing costs may vary by a factor of five. The location and arrangement of field-mounted instruments play a major part in the final choice.

Valve Actuators. There is also much development work underway on the control-valve actuator. Until the response of this actuator is improved, the speed of the electronic control system cannot be utilized fully. In addition to these problems that must be solved by the manufacturer, the instrument user has a problem—he must keep pace with these latest developments. Otherwise, he will find he lacks first-hand experience in reliability, maintenance and operator training for the better equipment.

Data Handling

Use of electronic instrumentation is increasing with the introduction of data-handling systems. A complete data-handling system for process applications would perform the following operations.

1. Accept input-signals for flow, pressure, temperature, and other variables.
2. Printout a complete log-sheet at regular intervals or on-demand.
3. Continuously scan variables for off-normal conditions.

In addition, many auxiliary functions may be performed. For example, a digital-indicator can be used for on-demand readout of any one point. A trend-recorder may be used for tracking one or more variables. Computations such as totalizing, averaging, and determination of unit-efficiency can be performed. Digital output can be recorded in the form of perforated-tape, punched cards, or magnetic-tape. The cards or tape can be fed to computers for further computing and accounting operations.

Tangible savings can be realized by installing data-handling systems. The system permits reduction in the number of instruments on the controlboard, resulting in savings in instruments, controlboard, and control room. Since data are automatically logged, the operator is free

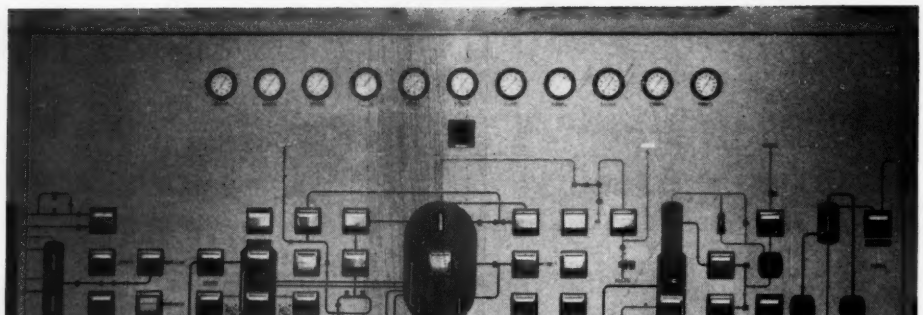

Fig. 2. Example of modern graphic panel with miniature instruments.

to perform other important duties. This more efficient use of operator time can be converted into further dollar savings.

Still other advantages cannot be evaluated readily in terms of dollars. In addition to savings of operator time, use of data-handling systems reduces the clerical services required to tabulate and summarize data. Automatic data-reduction and computation provides daily summaries of unit operation for accounting, engineering, and management, without duplicate effort. Management can make up-to-the-minute evaluations of all operations.

Further, automatic logging and off-normal scanning allows the operator to devote his full attention to corrective measures during an emergency condition. Invaluable records are provided for later determination of the cause of upset. Scanning and logging records cannot be falsified; because of this, the supervisor has a true picture of the conditions during an upset.

Computer Control

More efficient and more complete automatic control of processes of the future requires extensive studies by both process and control engineers. Data-handling systems are one of the most important tools for obtaining data for these studies. From the analysis of process and data we feel there is a need for the development of a computer designed for process-control requirements.

More emphasis must be placed on both the dynamics of the process and the proposed control-loops. Much of the judgement presently exercised in process design must be replaced by the applied mathematics on which the computer logic relies. The output from a data-handling system then can be fed into such a computer. The computer would be programmed to re-adjust control elements in order to attain maximum plant efficiency. By this method, the many independent control-loops of today would be tied together into an integrated control system. Again, we must obtain actual operating familiarity with the data systems now offered for the process industries before we can soundly approach the development of computer control.

Composition Analyzers

The continuous composition analyzer will play its part in automatic supervisory control, and will eventually be tied into the same computer described for data-handling outputs. The most important data required for plant control are composition analyses. In present laboratory

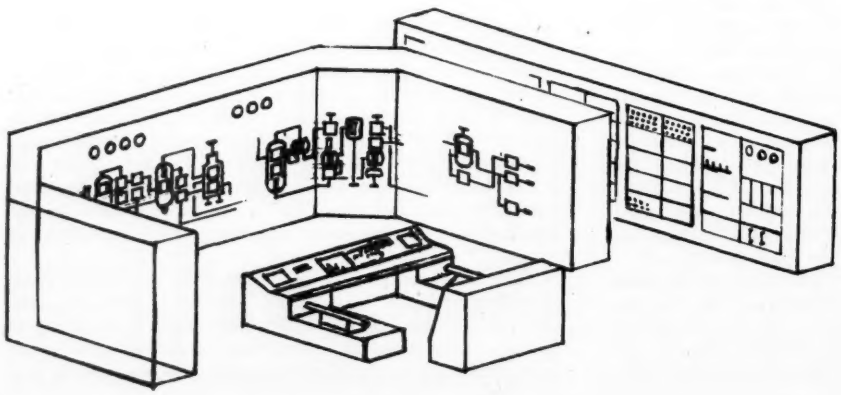

Fig. 3. Graphic panel with miniature instruments and data handling for same process shown at top of Fig. 1 requires 48' controlboard, and 1380-sq-ft room (43' x 32'). Many indicators and recorders are eliminated because of the data-handling technique.

techniques there is a long time-lapse between the taking of the sample, running lab-tests, and making corrective adjustments. In addition to the time lag, there is the problem of intermittent sampling; process conditions often change completely between taking the sample and obtaining lab results.

There are now available several types of continuous composition analyzers:

Mass spectrometers
Infrared analyzers
Ultraviolet analyzers
Viscosimeters
Specific-gravity analyzers

These instruments can be used to automatically reset conventional controllers to meet desired product specifications, or as a guide for manually adjusting the controller set-point.

Payout. Economic justification for these instruments is easily shown for most processes. For example, let's look at the application of a mass spectrometer in a sulfur plant. Plant capacity is 35 to 40 tons per day. The sulfur product is valued at about thirty dollars per ton. By the installation of a $10,000 mass spectrometer, a refiner improved operating efficiency by 2 to 3%. This improvement paid for the spectrometer in less than one year. With larger throughputs, the savings due to elimination of off-spec products and reruns represents even more money.

Rental Plan. There are, of course, marginal cases where economic justification cannot be shown so easily. For such cases, many analyzers are offered on a rental basis. This permits the user to evaluate the effect of the instrument for his particular application. If operations are improved, he can justify the purchase of the analyzer. Most rental plans allow the rental payments to apply to the purchase price.

Control-Room Size

Most of the instrumentation which we have discussed is located in a control room, the operating nerve center of the plant.

Large. Ten years ago large-case instruments were the accepted standard. Big control rooms were required to house these instruments, and familiarity with the process and considerable experience were required of the operator. Several years ago, graphic panels were developed as processes became larger and more complex. This, in turn, led to the development of miniature instruments.

Medium. The control room of today presents an entirely new concept of process instrumentation. Graphic panels with miniature instruments offer several advantages—all instruments are presented in a more compact display; operator training is simplified; supervision of process control is more centralized and better coordinated.

Small. The increasing use of data-handling systems will decrease the number of panel-mounted instruments. Readout devices for the system will be located on an operating console, and the graphic-panel display will be reduced to a small flow diagram at the console. Small alarm-lights, miniature instruments, and compact controlboards will permit future operations to be carried out in an office-size control room. Several savings will be realized from such an arrangement—fewer operators will be required, and the smaller room will be less expensive.

Specific Cost Comparison

Let us illustrate the application of some of these trends to a specific process unit. We have selected a modern crude-unit now under construction. This is a large unit with a throughput of over 100,000 barrels a day. The unit plot is some 450 feet square. This unit will serve as a basis for comparing the costs of several alternative instrument systems.

Pneumatic Versus Electronic. For this unit, we compared wire in rigid-conduit against cabled copper-tubing. Because of the arrangement and location of the instruments, we did not find a significant difference in the installed costs of transmission.

Next, we looked at the cost comparison between the instruments proper. The electronic systems, in some cases, require one less component; in other cases the nearest electronic equivalent to a pneumatic instrument cost considerably more. We found that the electronic instruments ran some 30% higher than pneumatic.

Influence of Data-Handling. Our basis is a complete system incorporating all the data-handling functions previously discussed. Many recording and indicating functions have been transferred from the controlboard to the data system. All controllers remained on the board. However, many recording controllers now became indicating controllers. This reduced the number of boardmounted instruments by 40%. The board length could be cut from 75 to 50 feet. These savings amounted to some $30,000. Better utilization of manpower allows us to use one less operator per shift. On this basis, the remaining cost of the data-handling system is paid for in about two years. In addition, we have gained the many advantages already discussed, including complete, high-speed and reliable data-recording, continuous process monitoring, and a summarized presentation of plant operation.

Use of Small Control Room. As we rely more and more

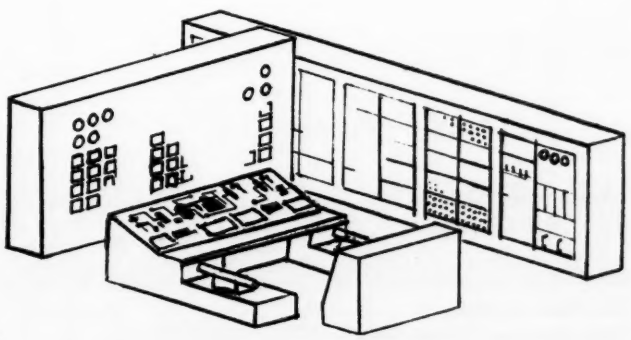

Fig. 4. When graphic display is miniaturized and transferred to the operating console, the controlboard of Fig. 3 is reduced to 16' and controlroom to 700 sq ft (28' x 25').

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Study and analysis of the digital differential analyzer in the solution of engineering problems—integral evaluations, non-linear functions, split-boundary-value problems, etc.
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on the data-handling system, we can transfer the graphic-display from the main board to the operating console. Instead of a 50-foot graphic panel, we now consolidate the same number of miniature instruments onto a board some 20 feet in length. The operating-console, data-handling system equipment cabinets, and the compact controlboard can be housed in a much smaller control room. We reduce the control room by 60% and save approximately $10,000. Add to this a $6,000 reduction in controlboard cost. Overall, we reduce the initial investment by some $16,000 by the use of the compact controlboard.

Three control-room drawings illustrate the evolution of control-room instrumentation. Each drawing is based on the specific crude-unit we are using as an example. Fig. 1 shows the controlboard as it might appear using large-case instruments; approximately the same length controlboard would be required for a graphic-panel with miniature instruments and without a data-handling system. In Fig. 3 we see the control room as it was actually installed. In the instance the data-system allows us to delete many indicating and recording instruments from the controlboard. The control-room floor area is reduced by 23%. Fig. 4 shows the effect of using miniature instruments in a compact arrangement with the graphic presentation on the operating console. With this arrangement, the required control room area is reduced some 60%.

Equipment Savings. If surge capacities and vessel sizes were reduced by only a few percent, the savings in equipment costs would be appreciable. We have not evaluated such savings in our example. For such a large unit, however, these savings could well represent a large portion of the total instrument cost.

Although this cost comparison favors pneumatics, we must be careful about generalization. Each process unit must be evaluated by considering plot-size, instrument arrangement, and the current costs of piping and wiring methods.

Responsibility of Operating Companies

The instrument manufacturer has little opportunity to gather facts which give economic justification to many of the systems outlined here. However, he is in a unique position. He is ahead of the user; he is waiting for his instruments to be field proven, and for their wider application to catch up with current design.

This unique circumstance throws our industry a clear challenge. The progress to be made in automatic control and data-handling systems is largely in the hands of the operating companies. A combined effort is therefore required to obtain the maximum benefits which are now available to us.

He who lets others do the pioneering will have difficulty in evaluating the new equipment and their operating techniques. Although practical experience is most important to the user, both the instrument manufacturer and the contracting engineer must do their part.

Only by taking full advantage of the improvements in instrumentation can we obtain the highest profits by greater operating efficiency, increased product quality, and better utilization of manpower. It is through these advantages that instrumentation plays its part in our expanding economy.

The rate of advance towards this goal hinges largely on our ability to put in the hands of Management facts and figures which will cause them to turn from the instruments which have been used in the past to those which are offered today.

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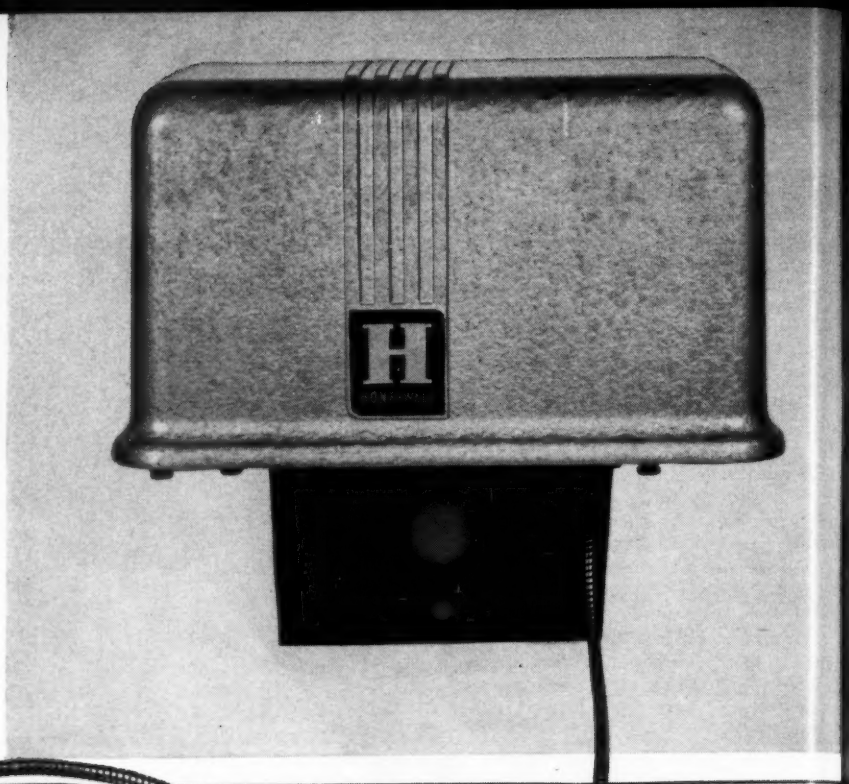

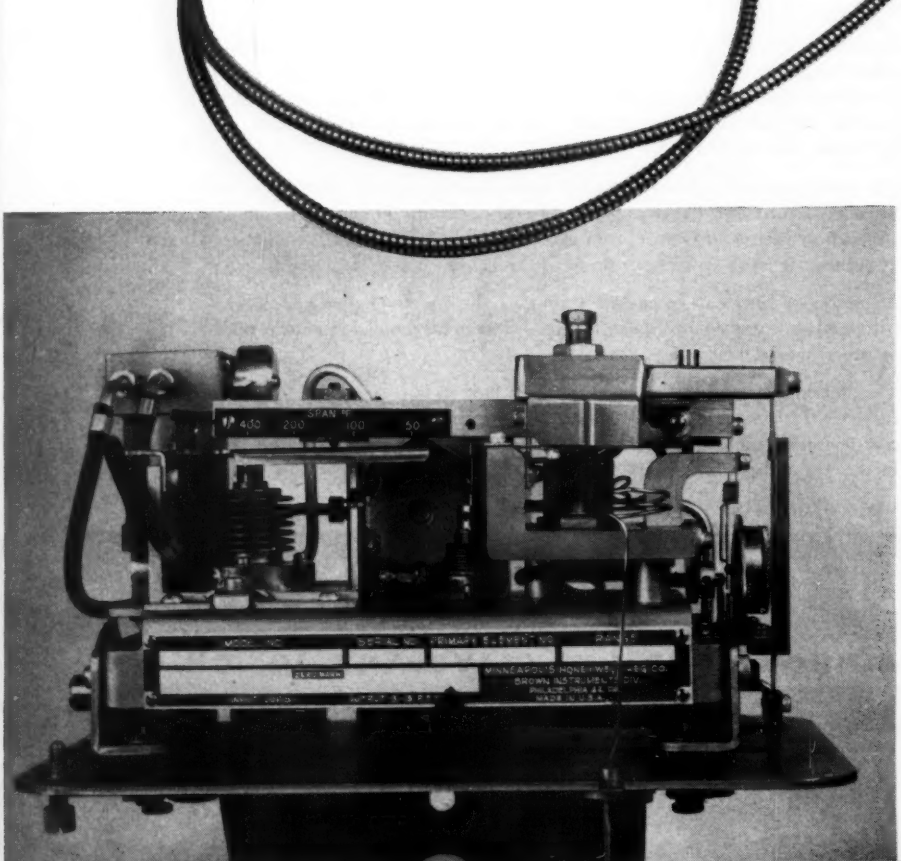

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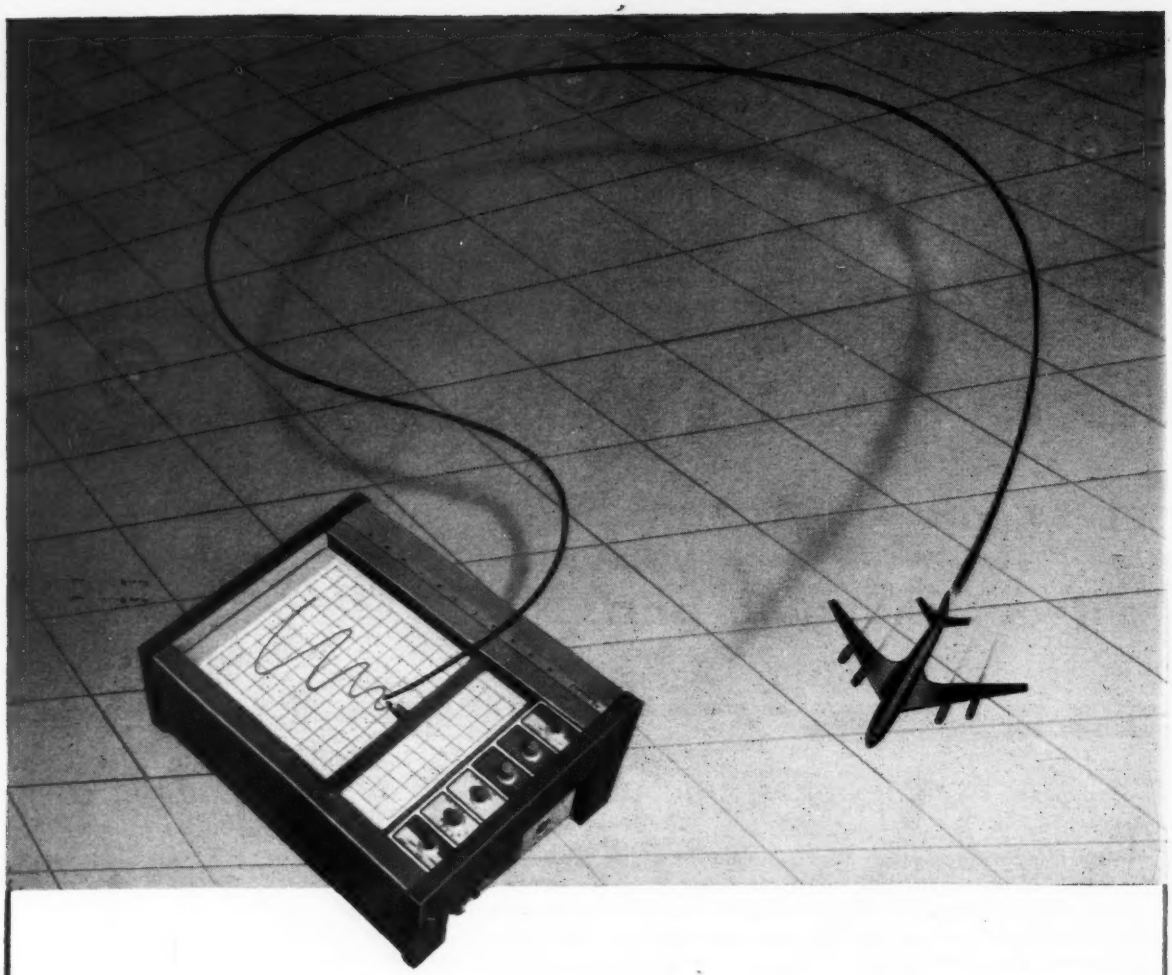

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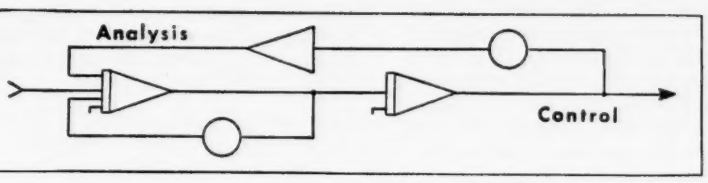

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Bits

No space for your Ed. to put in his two-bits' worth—too much real info this month. First is an almost verbatim report of a panel discussion on combined analog and digital systems intended to convey a "feel" for the subject—why it is so interesting and important. This is followed by brief descriptions of several kinds of hardware which have been produced to make the combination possible.

Pieces

PANEL DISCUSSION, DENVER RESEARCH INSTITUTE'S THIRD SYMPOSIUM ON COMBINED ANALOG & DIGITAL COMPUTATION, DENVER, 30 AUGUST 1956

John McLeod (moderator): The objective of this panel is not so much to inform as to stimulate thinking. One excellent stimulus to thinking is a good old-fashioned bull session, whether on Topic A or on computers. Today we will try to keep our minds on computers. This panel was organized (and I use the word loosely) to stimulate thinking through discussion. The panel members were selected not so much because they are "experts" (you may fill in your own definition of expert) as because I believe their varied backgrounds and interests make them representative of the rest of you here. All present are invited to join in the discussion by comments as well as questions. In this way we can bring out the what, why, who, where, when and some of the how of combined digital and analog systems. I would now like to introduce my panel:

Eric Weiss (Daystrom Systems Division of Daystrom, Inc., La Jolla, Calif.); **Bob Leger** (Convair-Astronautics, San Diego, Calif.); **Joe Hussey** (Berkeley Scientific Division, Beckman Instruments, Inc., Richmond, Calif.); **Larry Silva** (Scientific Instruments Division, Beckman Instruments, Inc., Fullerton, Calif.); **Frank Richmond** (Glenn L. Martin Co., Baltimore, Md.); **David Prince** (Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Ga.)

Before starting the discussion I would like to make one thing clear: we do not intend to belabor the question of which method is better, analog or digital. I hope that everyone present realizes that this is a question which can be answered only by intelligent consideration of what in heck you are trying to do; what are your inputs and what do you expect to do with the output; is much computation involved; and what are the speed and accuracy requirements? However, it might be interesting to review some of the pertinent points, good and bad, of analog and digital techniques to build a foundation for the rest of our discussion. Joe, what do you believe are the most pertinent capabilities and limitations of analog computers?

Hussey on Analogs

Joe Hussey: The basic advantage of the analog machine is its high speed. It is capable of simulating physical systems having natural frequencies of 1,000 cycles or higher. This is difficult at 1,000 cycles on a digital machine because a sine wave should have several hundred points computed per cycle in order to plot. This means computations at the rate of several hundered thousand per second.

The main limitation of the analog is that you are measuring voltages to

determine the value of the real variable of interest. These voltages unfortunately have a horrible habit of wandering around with time, and if you are integrating over very long intervals the analog error tends to be relatively high. It seems therefore that in a digital-versus-analog discussion, a first approximation of which is better for one job can be reached by considering the frequencies involved. As to accuracies, with analog equipment you won't get much less than 0.5 percent error no matter how you beat it, whereas with a digital machine it is only a question of how long you wish to take to calculate to get a relatively accurate numerical answer instead of your interpretation of the reading of some meter or recorder. A big advantage of the analog is that its speed allows you to operate in real time and therefore to tie into physical equipment.

McLeod—Thank you, Joe. Eric is well informed on digital computing techniques. I am therefore going to ask him to do for digital computers what Joe has done for analogs. I do not, however, wish to imply that Eric is prejudiced! He could probably do as good a job for analogs.

Weiss on Digitals

Eric Weiss—As John says, I do not have anything against analogs. In fact I grew up with analogs and got into digital work later, so I have to agree with Joe Hussey's points in favor of analogs, and of course if you take the negative of that you will get the points for digital.

In digital work you can get almost infinite accuracy at practically no additional cost except perhaps some additional computation time. With a digital computer you can compute a very complicated program just as easily as you can a simple one. It doesn't take any more equipment, just a little extra time. Or you can go to a special-purpose machine, in which case the more you do the more it costs, but it is possible to do it concurrently. An advantage of digital work is that it is exactly repeatable. You can do a problem any number of times and get identical answers. In digital work you can go to more intricate decisions. A general-purpose digital machine can be programmed or a special-purpose one can be built to make very intricate decisions. This requires only that you be able to give the machine definite instructions on which to base its decisions, because machines cannot think.*

McLeod—Thank you, Eric. A point was brought forcefully to my attention recently in the MIT course "Analog-Digital Conversion Techniques". Assuming that your original information is in analog form, as it is likely to be in nature, and you digitalize, then you are working with a sampled data system. This brings up all sorts of complications which I am certainly not going to get involved in now, but which I think you should bear in mind if you are considering digitalizing any analog information.

Bob Leger started serious consideration of combined analog and digital simulation over a year and a half ago. Based on early computations it was determined that a large combined analog and digital simulation was feasible, and subsequent work by Bob and his colleagues resulted in the specifications for the Addaverter (*a*nalog-to-*d*igital-*d*igital to-*a*nalog con*verter*) equipment currently being manufactured by Epsco for both the Convair and the Ramo-Wooldridge combined simulations. This simulation was undertaken to take advantage of the better capabilities of both the analog and digital computers without paying too high a price. Bob, will you tell what you are trying to do, and why and how?

Leger on Reasons for Combined Computations

Bob Leger: Suppose you start out with a relatively simple problem and want some ballpark answers. You set it up on an analog computer and get your answers in relatively short order. Then you introduce more and more details and the problem becomes more and more complicated. The price you pay for this on an analog computer is that it takes more equipment and your errors build up until you finally reach a point where you just can't go any farther. In general this costs you practically nothing in speed. Phase lag might build up to cause instability, but in general the difficulty is loss of accuracy.

With an all-digital system, as you add complexity you do in general lose a little accuracy because of round-off effects, but this is usually unimportant as compared to errors introduced by your original assumptions. However, because you are time-sharing your equipment it takes you longer. Futhermore, if you are simulating a system with high-frequency components you have to sample frequently and so are slowed down severely.

As has been mentioned, an advantage of an analog system is that you can tie actual physical hardware into the system and thereby include effects like friction and backlash which might not otherwise have been picked up. This suggests a combined simulation where part of the problem is solved on a digital computer and part of it on an analog, with the analog giving you something to tie your physical components to. But as soon as you put hardware into the system you are forced to operate in real time. You therefore must get all of your digital computations done in such a short time that you have to shift some of the computing load to the analog computer.

A happy situation occurs in many systems which we wish to simulate: the system itself is basically a closed-loop feedback system, with a forward portion of relatively low accuracy. An attempt is therefore made to get accuracy by using a high-accuracy feedback loop. Fortunately you can do exactly the same thing in the simulation. You can use a relatively low-accuracy analog forward loop and then put a high-accuracy digital feedback loop around this and thus get good overall accuracy.

McLeod—Thank you, Bob. Bob has briefly outlined one reason why we want to tie analog and digital equipment together. Now I believe Larry can give you some quite different reasons for combining techniques.

Silva on Problems of Combined Computation

Larry Silva—It has been my experience that when you tie analog-digital equipment to a real live system with 20 to 30 inputs you run into real difficulties because there isn't a digital computer available with a fast enough clock rate. The digital computer just can't physically handle the data. As an illustration, we regularly use some analog-to-digital

*Define "think"!—Your Ed. doesn't know what it means—literally!

The National Simulation Council will meet Wed.-Thur. afternoons, Nov. 28-29, at the Trade Show Bldg., 500 Eighth Ave., New York, N. Y., in conjunction with the Third International Automation Exposition. Each of the four Councils will hold one of four afternoon sessions. The Eastern S/C will have a morning meeting at Project Cyclone on Thur. Nov. 29. See opposite page for tentative program.

conversion equipment that spews forth anywhere from 100 to 80,000 digits per second. At the higher rates all computing equipment is bogged down. If you have to do a couple of computations on each input, which will take from 2 to 5 word times, and there are 20 inputs, that may mean 100 word times between successive sampling periods. Now according to Shannon's theorem, you must sample at least twice for the highest frequency components. This places severe limitations on the real systems that you can tie a digital equipment to. If, however, the data inherently exist in the analog domain and you follow the philosophy set down by others of this group and use a combination of analog and digital techniques, you must have some amplifiers before you get into the digital domain. Our present thinking is that for every analog amplifier which you must thus go through, you should do as much as possible before going into the digital domain. In this way we get the analog equipment to do scaling, addition and subtraction and other operations for which it is ideally suited, and relieve the digital computer of some of the work it would otherwise have to do. The combined system can thus be operated in real time.

McLeod—Thank you, Larry. Your reasons are quite different from those which made Bob Leger want to combine the systems. However, in both cases the two techniques have been combined to do one job. Frank has had experience in using the two to complement each other in a different way. Will you tell us something of your work Frank?

Richmond on Auxiliary Uses of Digitals

Frank Richmond—As you know, originally the only way of checking analog computation was to solve the problem some other way, either by hand or by the use of a digital computer. This is of course not using the techniques in combination. However, it is possible to program a digital computer to analyze analog data almost as fast as it can be computed, and perform checking this way. Often this checking is only partial, but it is possible to program a checking procedure so that when analog data is fed into it, plots can be obtained. This is the principal application with which I have had experience.

As analog computers get more complex other applications are obvious: for instance, programming a problem for an analog computer. There are many operations suitable for digital computers which are now being done by people with desk calculators, such as computing scale factors, coefficients, and so forth. And a lot of checking can be done in advance by computing what you expect to get. This sometimes involves considerable calculation which could be done more quickly on a digital computer.

Another important use for a digital computer is determining from the results of one run what should be done in the next. Analog programs requiring such computations can be speeded up a good deal by the use of digital computers. Thus the analog doesn't have to sit idle while the conditions for the next run are computed by hand or on a desk calculator. A digital computer to be used as I have outlined need not be large as a computer capable of solving the entire problem, but it should be constantly available.

McLeod—Thank you, Frank. In the paper preceding this discussion Jerry Greenstein (Convair-Astronautics, San Diego) described some of the very expensive, very special-purpose equipment which we hope to use to tie the Convair analog and digital computers together. In contrast to this, Dave Prince has been doing some work on analog-to-digital conversions with the kind of standard laboratory equipment which might be available to any of you. Dave's conversions might not be made with the accuracy and speed of the Add-averter, but I think that some of you might like to do some analog-to-digital conversion with your standard laboratory equipment and will therefore be interested in hearing about Dave's work.

Prince on Conversion with Available TIMs

Dave Prince—At Georgia Tech a large digital computing center containing an ERA 1101 and an IBM 650 has recently been established. We also have a 40-amplifier analog computer facility with associated nonlinear components. Last year we built and demonstrated a successful analog-to-digital converter which plotted curves on a stack of IBM cards. Of course there is standard equipment on the market to do this, but our device did work on a novel principle.

Just this past week we demonstrated a simple means for obtaining analog-to-digital conversion on our analog computer. To do this we used only our standard analog equipment and a time interval meter. The idea is quite simple. When we push the compute button a linear time sweep is initiated. When the amplitude of this linear sweep reaches coincidence with the DC voltage of interest it stops the time interval meter. The time interval meter counts the microseconds from the start of the sweep to coincidence and thus produces a number proportional to the DC voltage. In our experiments last week we obtained accuracy of the order of 1/10 of 1% with the sawtooth sweeping at the rate of 100 volts per second. Of course this data rate is not adequate to feed a digital computer, but it could feed some sort of digital readout or card punch, or be used as a digital voltmeter. We plan to go further into the converter problem, but as our laboratory is newly-established we have not yet been able to.

Tentative Program of National S/C Meeting, Nov. 28-29:

Wed. Nov. 28: 1300—Midwestern S/C meeting; features of the new simulation center being built for WADC.

1545—Western S/C; program to be announced.

1700—Cocktail party and social.

Thur. Nov. 29: 1300—Southeastern S/C; program to be announced.

1545—Eastern S/C Program: Simulation of Time Delays. See note on opposite page for Project Cyclone trip.

Prince Raises Question of Accuracy

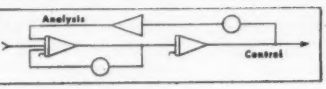
If it is OK, John, I'd like to ask a question: In view of the somewhat restricted dynamic range of the operational amplifier and the finite noise level, I would like to know how many binary digits it is practical to carry along in the digital part of a combined problem.

McLeod—Eric Weiss?

Weiss—Roughly, carry twice as many binary bits in the middle of a complicated computation as you need in the answer for the accuracy you want. I have had incoming data of 8 or 9 bits. We had the digital machine carry 16 bits, and the output was good to one part in 8 bits, or one part in 256.

Silva—I can give you some specific answers in the low-level area. In the range of 10 microvolts and a few hundred cycles per second we regularly observe dynamic ranges of 20 to 30,000 to 1. Now Joe over here may be able to give us a feel for what the dynamic range is when the signals are at much higher levels, as in an analog computer.

Hussey—It is my personal opinion that one part in 10,000 in a high-quality machine is not out of the question. The problem is not so much accuracy, as people would have us believe, as it is bandwidth. For years people have been listening to their phonographs with a very restricted



bandwidth. To get better reproduction they built a better speaker system. This would correspond to our building a better amplifier. We finally found in hi-fi that we must have the low frequencies handled by one system and the high frequencies by another. Basically this is what Bob Leger was talking about; they plan the digital machine for the low-frequency components and the analog for the higher. Thus they will have a combination which will cover a very wide band.

Silva—You are talking about bandwidth, but as I understood it Bob Leger was talking about increased accuracy. I wish someone would clarify for me the value of the increased accuracy in view of the fact that you derive all of this information from analog transducers.

Leger—I think maybe I can answer. It goes back to the idea that the analog portion of the simulation is used to represent the forward loop of your system. If the accuracy here is all you want you could leave out the feedback loop. The feedback loop enables us to take an inaccurate output, measure the inaccuracy against some reference which might be digital, and then use this for correction. With respect to dynamic range, we set up our specification with this problem specifically in mind. When we first looked at our problem we divided the maximum error we could tolerate by the maximum value that the function might have, and wound up with a figure of one part in 100,000. We knew right away that if we went to some manufacturer of converting equipment and asked them to design equipment accurate to one part in 100,000 we wouldn't get anywhere.

However, the system we wish to represent is a feedback system which is trying to cause some quantity to approach zero. This quantity may go through a wide dynamic range, but the important thing is to approach zero with great accuracy. So we concluded that we could tolerate a nominal error while the signal was large, but as the signal got smaller we had to have greater absolute accuracy. So we wound up with a specification that accuracy should be 1/10 of 1% of the actual voltage *or* one millivolt, whichever is larger. This gives a dynamic range of one part in 100,000 but at no place do we specify accuracy greater than 1 part in 1,000. The equipment Epsco is building for us is supposed to be better by a factor of 2.

McLeod—A while ago Larry Silva mentioned that according to Shannon you must sample at least twice per cycle of the highest frequency. I would like to point out that this must be the highest frequency present, not the highest frequency of interest.

Silva—I can clarify that. Shannon's theorem assumes that you have information in a certain bandwidth and no information outside that. However, if you have a 3DB bandwidth and a 6DB per octave roll-off and you analyze the error in the conversion, or the sampled data process, you will find that in order to get 1% RMS accuracy you need something like 1,000 cycles per sample of the 3DB frequency.

McLeod—In other words you too are looking for that perfect filter.

Silva—This is a reality of life. However, this assumes that all frequencies over the bandwidth are equally important. In most physically realizable systems this is not true, so 1,000 samples per cycle is a bit too stringent; you need not go to quite these extremes.

Weiss—We have been talking about accuracy, which reminds me of a problem we had at Hughes. Essentially we had a radar giving a picture on a scope. On the same scope we wished to put a reference map and information coming from a computer. We would compute deflection voltage on the scope in a completely analog way, which is certainly good enough because the radar isn't any better. But we could not index the radar data and the computer data. We had to get the two dots on top of each other because they were the same airplane. What we had to do was take the shaft rotation, go from that to a number, and then go from the number to the sine and cosine of that number, take the sine and cosine numbers, go back to voltages, and display these as a position on the scope. And we had to do that to 12-digit accuracy to match the computer within eyesight, even though the data wasn't that good by far.

I would like to take issue with something Larry Silva said about putting analog amplifiers in front of digital equipment to relieve the crowding of the digital equipment. This is OK, but there are other ways of doing it. For one thing, you can put special-purpose digital equipment in front of general-purpose digital equipment. In other words we can digest some of the digital data in the special-purpose equipment before we put it into the general-purpose equipment. This usually is cheaper than doing it analog-wise.

Silva—Eric, I would like to clarify this. Most of the equipment available requires minimally one amplifier ahead of the converter. We are forced to have that amplifier because of impedances or other considerations, and I say we should utilize it as much as possible. I was referring to those amplifiers which are inherently a part of the conversion equipment.

Weiss—In that case I can't argue with you.

McLeod—Now you have an idea where the talents and interests of the panel lie. Has this engendered any comments or questions from the audience?

Pantazelos Asks About Recent Trends

Peter G. Pantazelos (MIT, Cambridge, Mass.) asked for comments on the application of some of the specialized computing techniques developed during the past year.*

Weiss—The trend goes in two directions.

We try to eliminate access time. Most of the time of a general-purpose digital computer is wasted in trying to locate the information you need in the memory, and finding where to put the answer. If you do not have any access time you can do a complete three-dimensional coordinate conversion problem in one millisecond at the basic rep rate of only 120 KC. I did this as early as 1951.

The other trend is to speed up the basic clock rate, recently to about 4 megacycles.

Silva—When a general-purpose computer is fed by the Addaverter or any other conversion system our problem lies in the extremely difficult time we have communicating with the arithmetic unit. We are usually forced to go to an intermediate buffer storage which slows things up. I feel that this is an area where we must change the general-purpose machines. (Addressing the audience) Do you have any other ideas in mind?

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*We are sorry but Mr. Pantazelos' and some of the other comments from the floor failed to register with our electronic secretary.

McLeod—Dr. Skramstad, do you have any comments on that?

Harold Skramstad (National Bureau of Standards, Washington, D.C.)—I think Larry may be referring to some work done on a project called the DART, which is essentially a digital computer without a memory. You patch information around as in an analog computer. You have a little black box that is a summer and another little black box that is an integrator or multiplier, but each of these would be filled with digital gear, and only pulses would be passed from one box to another. Most people first think of the tremendous amount of equipment required by this arrangement. You essentially have a separate arithmetical unit in each box, but this is an approach which will give the extreme speed necessary for real-time simulation. I think we have almost reached the stage where it is feasible.

Weiss—It is not only feasible—it has been done. In the general-purpose digital computer we use about 5% of the total equipment to do arithmetic and the rest to control that 5%. If you cut the controlling you might be able to do 20 times as much arithmetic and still come out with about the same bill for a special-purpose computer.

Silva—In some of the equipment with which I am familiar we use a core memory and assign a particular row in each core for each variable, and time-share the high-speed arithmetic unit among these variables. Thus we overcome the disadvantages of the drum and slow-speed memories.

Weiss—There is an argument against sharing arithmetic units. Digital equipments *do* give trouble occasionally! In time-sharing, if something goes wrong it is difficult to know what. And until you have found out you must shut down your process. In military operations you can't do that. The practice has been to get rid of time-sharing and duplicate equipment 20 or 100 times if necessary. With present-day techniques you can make it small enough to fit into a trailer or an airplane.

Sampling Vs Accuracy

Someone* asked about the relationship of sampling frequency, bandwidth, and accuracy.

Silva—There is a theoretical analysis linking the sampling frequency, the breakpoint, and the DB per octave roll-off. At 18 DB per octave you have got 1% RMS accuracy at something like 10 samples at the breakpoint frequency. He** is right—if you can somehow filter your information to get an 18DB roll-off or greater then you don't need to sample at such a high rate in order to get 1% RMS accuracy.

Same Someone—I believe that in a recent publication Mr. R. A. Runyan of Electro-Mechanical Research discussed this aspect of sampling frequency.

Low on Statistical Studies and Data Reduction

Henry Low (Ramo-Wooldridge Corp., Los Angeles, Calif.)—Bob Leger has pointed out very well some advantages of a combined simulation. A point I would like to make concerns statistical studies. In the presence of noise you usually run 50 to 100 solutions. If you do this on a digital computer and are not working in real time, instead of taking 5 minutes you might take 15 or so. Imagine the time element involved!

Another point is that as long as you have this conversion equipment anyway, you might consider some open-loop applications, as for instance in data reduction. All you need is the usual standard tape recorder and you can do your cross-correlation or autocorrelation easily by taking the analog information from the tape and feeding it to the digital computer.

Leger—I agree. Certainly there are many open-loop things that could be handily and easily done if you had such a facility. One would be to take some of your data, run it into one of these converters, and plot the output directly on an xy plotter. You would have your data plotted in analog form while you were making the runs.

Insofar as the noise analysis goes, this brings in an economic factor, which is certainly important. There are other techniques which you can use if your system meets certain requirements. If the statistics of your system are nearly stationary, or if you take a certain piece of the run which is so short that the statistics do not change appreciably, you can in one sample get enough information (by the adjunct method) to economize greatly.

*Electronics—BOOOO!

**The gentleman the electronic secretary went out without!

MAY MEETING OF EASTERN s/c AT NBS ON "ANALOG-TO-DIGITAL CONVERTERS"

Approximately 68 members representing 35 organizations attended the Eastern Simulation Council's May meeting at the National Bureau of Standards in Washington to talk about "Analog-to-Digital Converters".

Taback on Analog-to-Digital Converters

Leonard Taback (National Bureau of Standards, Washington, D.C.) introduced the subject and gave examples of both analog and digital representation, indicating that analog quantities are continuous, whereas a digital representation is discontinuous and may have only a finite number of values.

Some of the factors to be considered in choosing analog-to-digital conversion equipment, Mr. Taback said, are:

1. Accuracy
2. Speed
3. Form of required data (serial, parallel, binary, etc.)

Gordon on DATRACs

Bernard Gordon (Epsco, Inc., Boston, Mass.) described the characteristics of the Datrac B Voltage-to-Digital Converter. These, which have appeared in these pages before, are given as:

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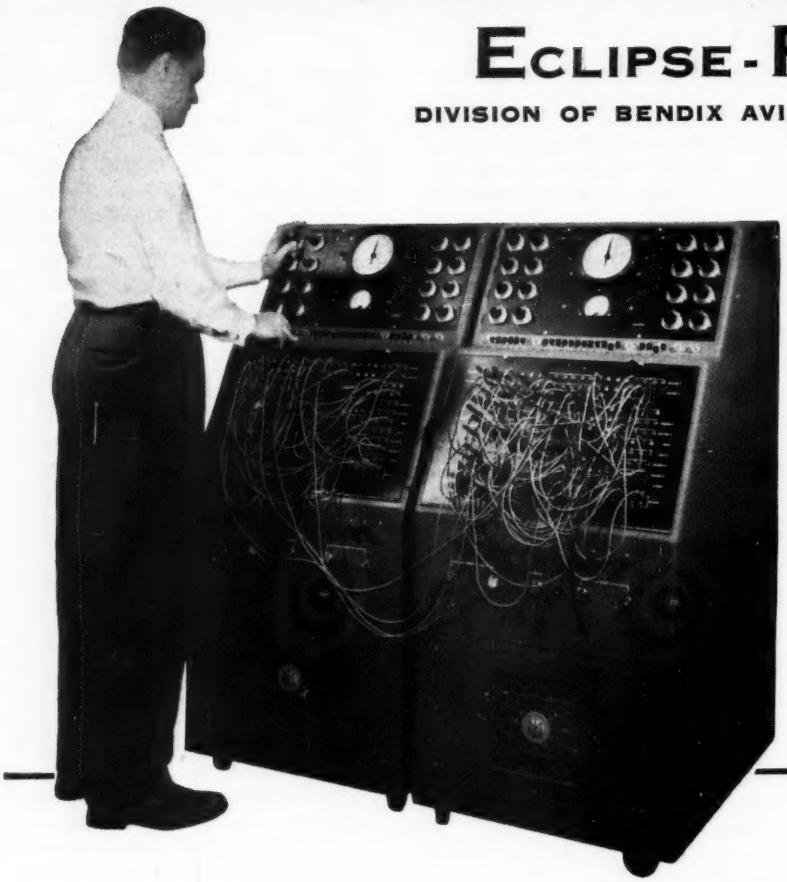

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Hurney on DACL Techniques

Paul Hurney (Hycon Eastern, Inc., Cambridge 42, Mass.) described equipment developed at the Dynamic Analysis and Control Laboratory, MIT, for the solution of differential equations using combined analog and digital techniques. He described two interesting systems, the basic elements of one of which are:

1. Magnetic drum
2. Digital-to-analog converter (DACON)
3. Coincidence detector
4. Gate
5. Storage register
6. Digital-analog multiplier

The precision of this system was given as 0.1%. A block diagram of one channel is shown in Figure 1.

The magnetic drum rotating at 125 rps is the information storage unit. Though only one channel is illustrated, a typical drum has provision for the storage of seven functions, a ramp function and several timing tracks.

The DACON converts parallel binary-coded information to analog form by means of a series of accurate current switches driving a resistance ladder.

The coincidence detector is a zero-sensing element. The ramp signal from the drum varies from −100 volts to +100 volts in one drum revolution, i.e. 8 millisecs. It is converted to an analog voltage by the DACON and when this voltage equals x, the input voltage, the coincidence detector generates a gating signal which transfers f(x), in the form of a binary-coded parallel signal, from the drum into the storage register.

The digital-analog multiplier is a unit which has an analog input v, and a parallel binary digital input from the storage register. The analog output is a product of these two inputs. Figure 2 is a schematic of the multiplier. Ten parallel conductances arranged in binary ratios are switched according to the input from the storage register to give any one of 1024 different values of total conductance. This forms the input resistance to a feedback amplifier, causing it to have a gain between 0 and 1 depending upon the condition of the switches. The eleventh bit from the register controls the sign of the digital multiplication by operating an electronic switch at the output of the multiplier. Since the analog input may have either sign, the overall result is a four-quadrant multiplier.

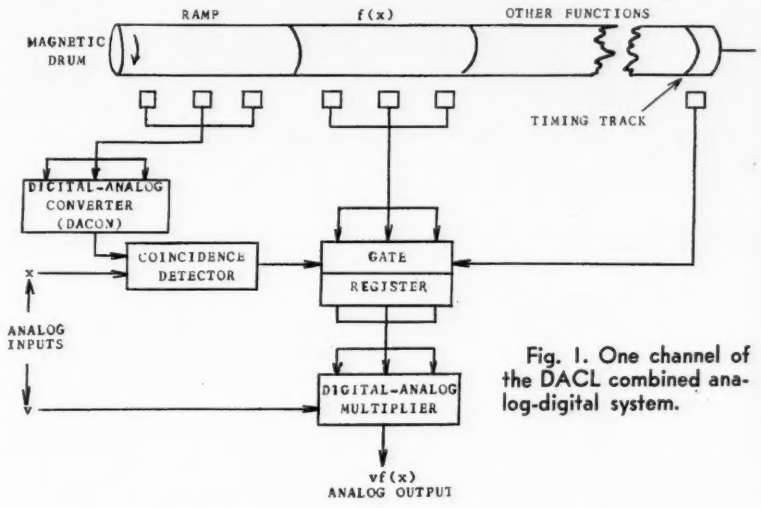

Fig. 1. One channel of the DACL combined analog-digital system.

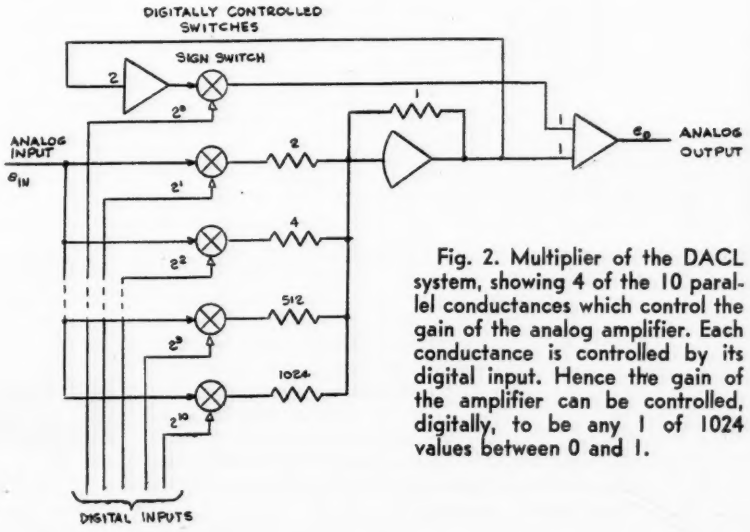

Fig. 2. Multiplier of the DACL system, showing 4 of the 10 parallel conductances which control the gain of the analog amplifier. Each conductance is controlled by its digital input. Hence the gain of the amplifier can be controlled, digitally, to be any 1 of 1024 values between 0 and 1.

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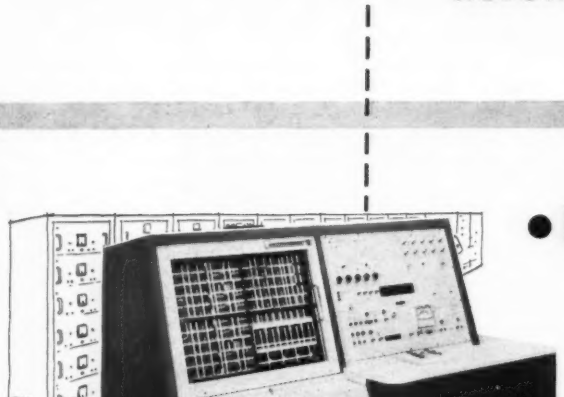

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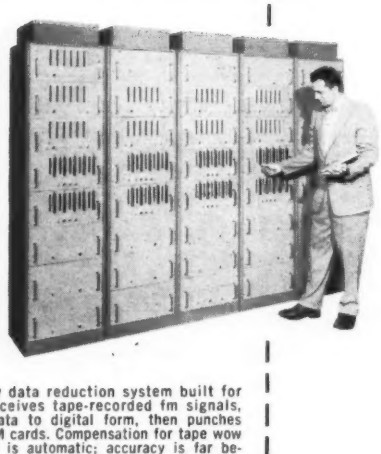

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For more information circle 74 on inquiry card.

R. Smith on the ACF Encoder

Ramon Smith (Avion Division of ACF Industries) described the performance and operation of the ACF analog-digital encoder which was conceived in 1953 at the National Bureau of Standards. The encoder consists of three basic sections: (1) The decoder-comparator with 10 precision input gates; (2) The code register, which contains the converted binary number; (3) The digital control circuitry.

The decoder-comparator is a chopper-stabilized d.c. amplifier with back-to-back biased diodes as the feedback. At the summing point are the input and the 10 gates which introduce standard reference voltages through a precision resistor network according to signals from the code register and the digital circuitry.

The analog input is converted to a binary number in 10 successive steps. Starting with the most significant bit, each gate in turn is closed by the code register. If the added reference voltage is too large at any step of the cycle, the output comparator becomes positive, and a comparison pulse which turns off the unwanted bit is generated.

The digital circuitry consists of a 10-stage ring counter, a 10-stage code register, diode gates, a clock pulse generator, run-halt flip-flop, comparator pulse generator, and serial output flip-flop and cathode follower. The ring counter and the clock pulse generator control the encoding operation cycle. The binary number is represented by the state of the code register flip-flops at the completion of the cycle. The register is cleared out by the run-halt flip-flop at the beginning of each new cycle.

Specifications of the ACF Model 1050 Voltage Encoder are:

Accuracy: Error less than ½ the least significant bit which represents one part in 1024
Speed: 0 to 15,000 10-bit codes per second
Full Scale: ± 1.5 volts
Input Impedance: 1000 ohms
Output: Serial pulse train

B. Smith on Cascade Encoding

B. D. Smith (Melpar, Inc.) described a method for converting analog signals to digital form by cascading two or more coding systems. The overall response time is limited only by the response of the individual stages. No sampling, timing, counting or other such operations usually associated with electronic analog-to-digital conversion systems are necessary.

Figure 3 illustrates one coding stage. The decoded output differs

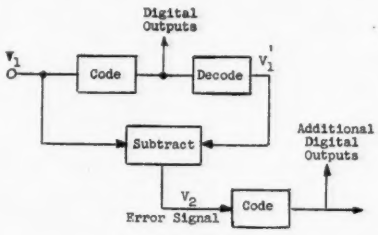


Fig. 3

from the input by some amount, called the quantization error, because the output is limited to one of a finite number of levels whereas the input is not so limited. If this difference signal is made the input to another similar coding system, additional useful binary digits can be obtained beyond those available with one coding system.

Figure 4 shows a block diagram of a system made by cascading three

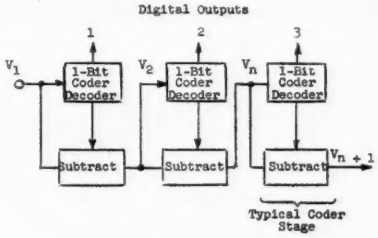


Fig. 4

coding stages. The first one-bit coder-decoder accepts the input signal, determines the first (most significant) bit, and provides a two-level first approximation to the input signal. The difference between the input and this first approximation is fed to the second one-bit coder-decoder. This process can be repeated through as many stages as desired. Each stage generates one binary digit and a signal to the following stage. Thus an n-digit coding system is made by cascading in relatively simple one-bit coding systems.

The properties of each stage of this coder can be specified in the form of two transfer functions of input-output

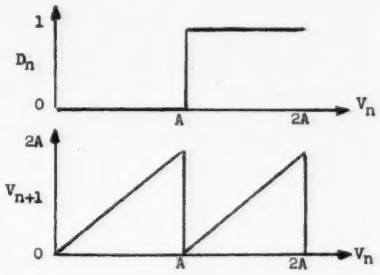


Fig. 5

relations as shown in Figure 5. The first transfer function specifies the desired relation between the digit output D_n and the input voltage V_n, i.e.

$$D_n = \begin{matrix} 0 \text{ if } V_n < A \\ 1 \text{ if } V_n \geq A \end{matrix}$$

The reference A is an arbitrary constant equal to one-half of full scale of the coder. The second transfer function specifies the desired relation between the input to a stage, V_n, and its output, V_n+1 (which serves as the input to the next stage). This relation is

$$V_n+1=2\ (V_n-AD_n)$$

This transfer function has the shape of a sawtooth.

These transfer functions can be achieved by numerous methods. Figure 6 shows one method employing

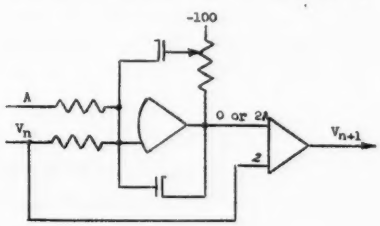
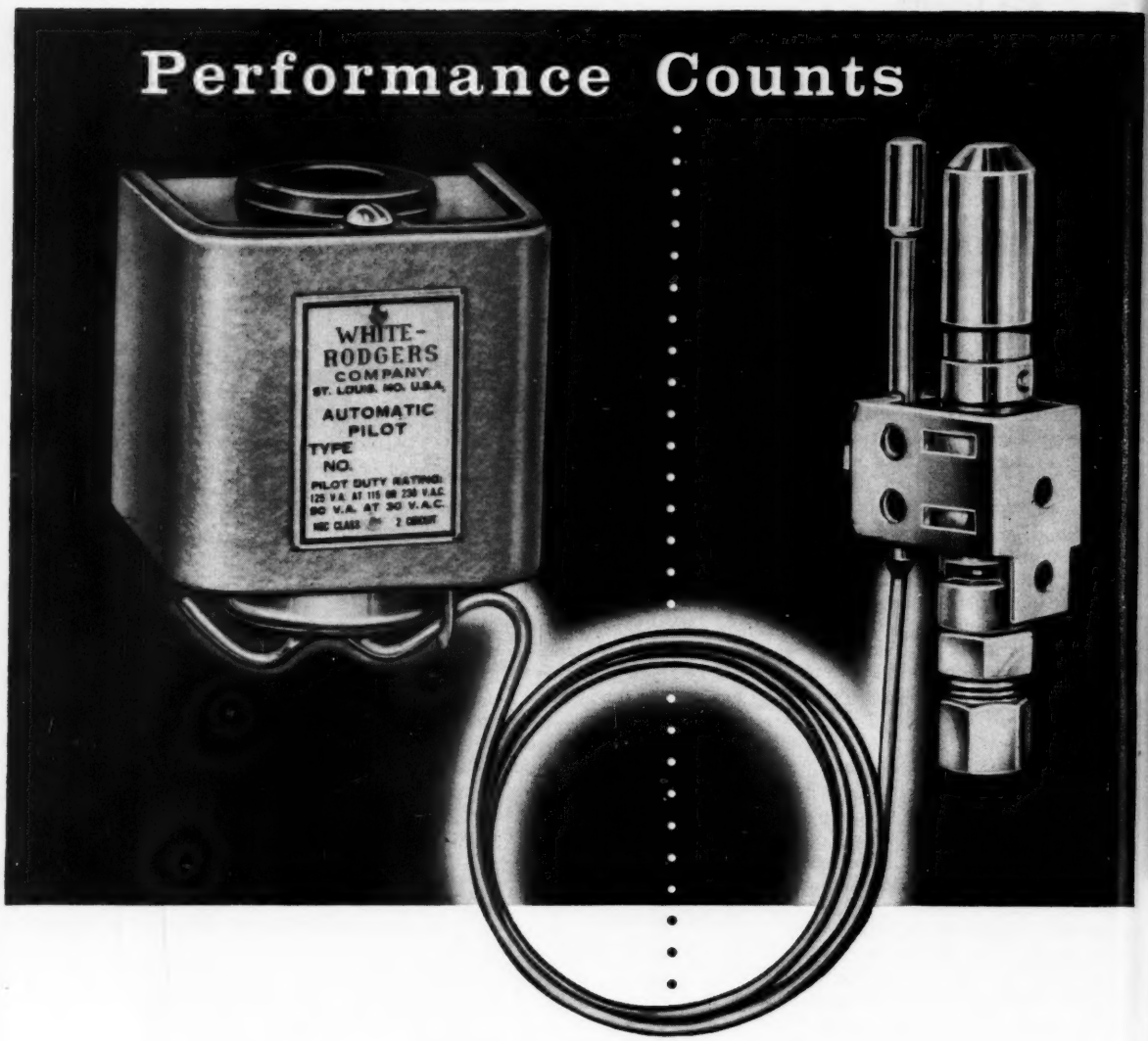


Fig. 6

operational amplifiers. The first amplifier performs the function of a one-bit coder-decoder. Its output is zero if the input voltage is below A, and is a positive voltage 2A if the input voltage is above A. The second amplifier combines the output of the first amplifier and the input signal to produce the desired signal to the next stage.

This basic coding method can also be extended to generate special binary codes such as the Gray code. Furthermore, by feeding the output of one coder stage back to its own input after a delay, a serial code can be generated using the one stage only.

Performance Counts



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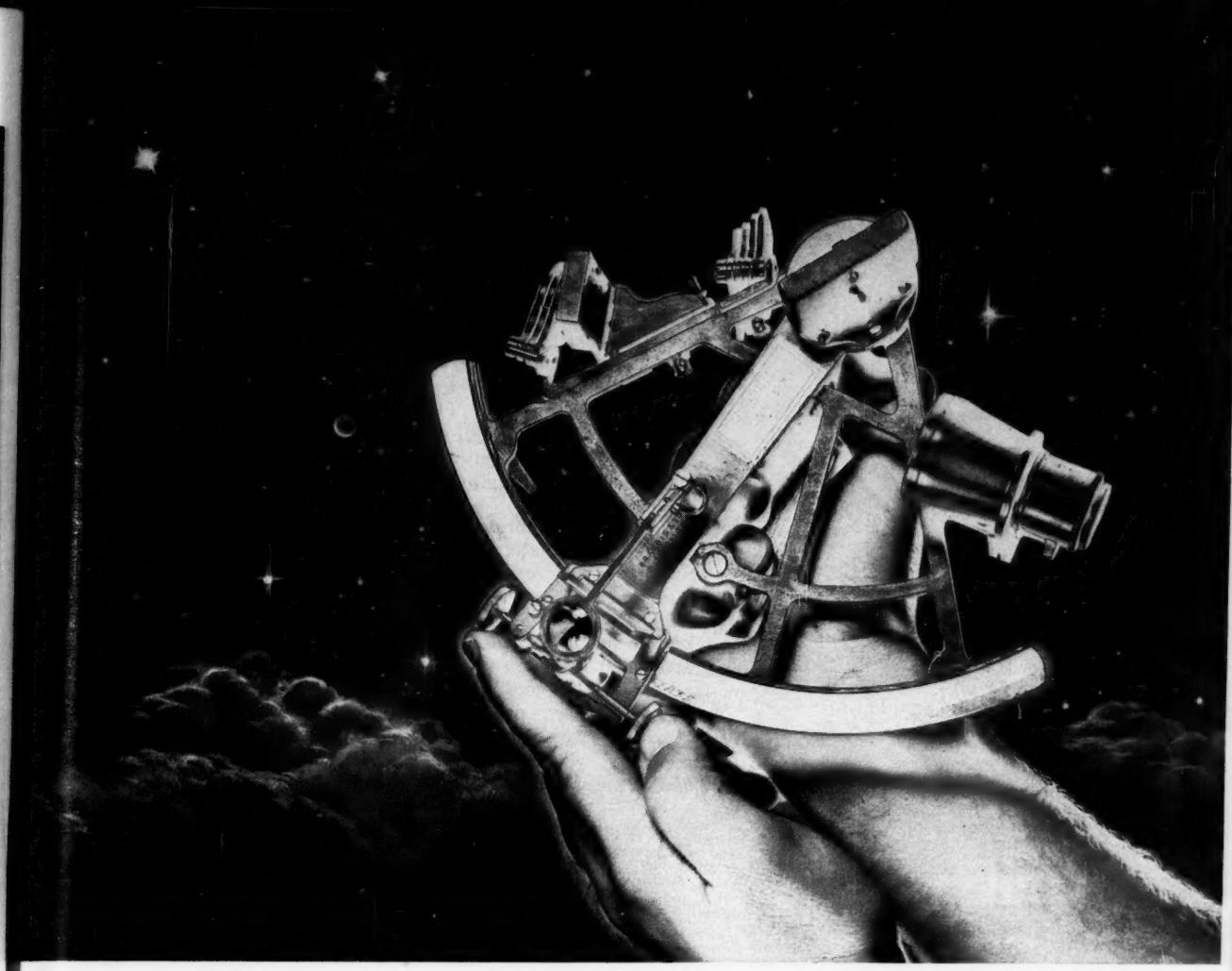

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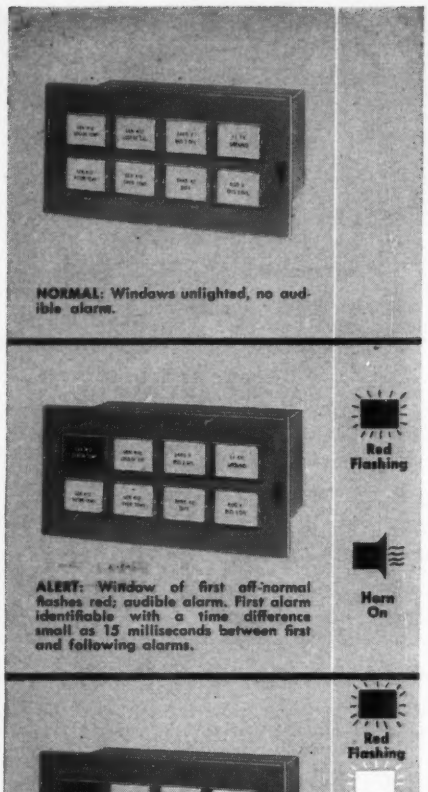
NORMAL: Windows unlighted, no audible alarm.
Red Flashing
Horn On
ALERT: Window of first off-normal flashes red; audible alarm. First alarm identifiable with a time difference small as 15 milliseconds between first and following alarms.
Red Flashing
White Flashing
White Flashing
Horn On
ALERT: Subsequent alarms indicated by flashing white windows now added to above condition. Signals lock in on momentary contact.
Red Steady-On
White Steady-On
White Steady-On
OFF-NORMAL: Operator presses acknowledgment button, silencing audible signal; visual signals change from flashing to steady-on.
Red Steady-On
NORMAL AGAIN: As conditions return to normal, white windows drop out, original red signal remains until reset button is pressed.

Panalarm "VS" Annunciator identifies first off-normal from subsequent alarms for rapid corrective action

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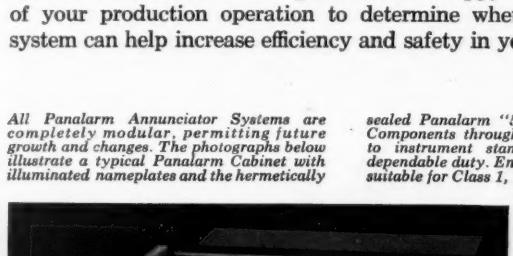
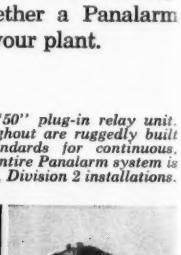
The original off-normal is clearly identified, enabling the operator to take immediate, corrective action. A considerable saving in down-time can often be effected simply by knowing the original source of trouble.

Panalarm "50VS" is completely flexible in setting up various sequential groups. Any number or combination of signals may be grouped as an independent sequence, and the groupings may be changed at any time by simple jumpers on the terminal block. Signals may be either illuminated nameplate or bullseye indicators, combined with a horn, bell or other audible signal. Signaling is simple and positive. A typical sequence is illustrated on the left.

Write for literature on the "50VS" and other Panalarm Annunciator Systems. A Panellit sales engineer will be happy to make a survey of your production operation to determine whether a Panalarm system can help increase efficiency and safety in your plant.

All Panalarm Annunciator Systems are completely modular, permitting future growth and changes. The photographs below illustrate a typical Panalarm Cabinet with illuminated nameplates and the hermetically sealed Panalarm "50" plug-in relay unit. Components throughout are ruggedly built to instrument standards for continuous, dependable duty. Entire Panalarm system is suitable for Class 1, Division 2 installations.





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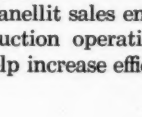
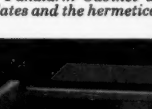


Panalog Information Systems

Graphic Panels Control Centers



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EXHIBITORS — — PRODUCTS

New York Trade Show Bldg.—Nov. 26-30, '56

Booth No.

AARD EQUIPMENT CO., Buffalo 5, N. Y. **405**

Exhibiting: Automatic machine and conveying equipment of Planet Co., Barnes & Reinecke, Inc., and others.

AIRBORNE INSTRUMENTS LAB., Mineola, N. Y. **114, 115, 302**

Exhibiting: Special and standardized gaging and control devices; components for machine tools.

ALDEN ELECTRONICS & IMPULSE RECORDING EQUIP. CO., Westboro, Mass. **321**

ALDEN SYSTEMS CO., Westboro, Mass. **321**

Exhibiting: Work Centers; Fact Finders-Timers.

AMERICAN TELEPHONE & TELEGRAPH CO., LONG LINES DEPT., New York 7, N. Y. **334**

Exhibiting: Page Automatic Sending & Receiving Teletypewriters; Receiving-only Typing Reperforators; equipment to be used in connection with demonstration of Bell System equipment for IDP.

In attendance: W. I. Flocken, Communications Engr. (in chg.); Mrs. M. M. Cooper, Misses A. Bobotis and J. T. Butler, Serv. Reps.; W. M. Guest, C. H. Drott, Communications Engrs.

ASKANIA REGULATOR CO., Chicago 11, Ill. **108, 111**

Exhibiting: "Electro-jet" units for conversion of low-level input signals to hydraulic power for production of thrust or torque in control systems.

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio **106, 107**

Exhibiting: New Products—LIAD multi-contact meter-relay for telemetering, max.-value-reading, analog-to-digital conversion, etc. Thermistor-actuated controls, alarms, and indicating pyrometers. New Simplytrol and Versatrol controls, and rugged-sealed 2½" clear plastic case panel meter. **Regular Products**—Contact meter-relays, APL panel meters, Simplytrol temperature controls, indicating pyrometers, VHS relays, Versatrol automatic controls.

In attendance: John Saint-Amour, V. P.; Robert E. Jones, Prod. Mgr.; Robert Pugsley, Asst. Sls. Mgr.; Lloyd Rowe, Paul Saint-Amour, Sls. Engrs.; Lionel Glauberman, Asst. Chf. Engr.

ATMOSPHERE CONTROL CO., INC., Philadelphia 43, Pa. **519**

Exhibiting: Controlled atmosphere test enclosures.

THE AUSTIN COMPANY, New York 11, N. Y. **553**

Exhibiting: New Products—Digital data recording system, accepts 100 channels of analog voltage (0 to +30 mv) information, sequentially tabulates the proportional digital value (0 to 10,000) for each channel speed 2 channels per sec nominal. Max. error 2 counts. **Regular Products**—Shaft Position Quantizer (Analog to Digital Converter); data recording systems; servo systems.

In attendance: C. L. Foster, V. P. & Div. Mgr.; A. H. Kuhnel, Asst. Div. Mgr. & Div. Engr.; W. G. Birkel, R. E. Schram, J. R. Poole, Proj. Engrs.; R. T. Callais, Asst. Div. Engr.

AUTOMATIC CONTROL ENGR. CORP., Westwood, N. J. **510**

AUTOMATIC TEMPERATURE CONTROL CO., INC., Philadelphia 44, Pa. **166, 167**

Exhibiting: New Products—Atcotran Demodulator—no vacuum tubes used in circuit. Atcotran Vertical Scale Indicator for ATC differential transformer system. Proximity Fuse, based on ATC system, has possibilities in nuclear reactor field. **Regular Products**—Atcotrol—automatic reset timer; Atcotran—differential transformer transmitters and receivers; Atcotronic—electronic timers; timing devices.

In attendance: R. B. Seidel, Pres.; W. W. Winters, V. P.; A. N. Clark, Adv. Mgr.; H. J. Oursler; J. Ash, Asst. Sls. Mgrs.; R. H. Kimber, Adv. Sls.; E. A. Wurster, Sls.; W. D. MacGeorge, Dir. of Eng.; W. B. Shinn, Chf. Engr.; R. Neill, Engr.

AUTOMATION ENGINEERING LABORATORY, INC., Greenwich, Conn. **541**

Exhibiting: Special automated machines for candy manufacturers, electrical hardware specialties, leather trade, pharmaceutical, paper box and automotive industries.

In attendance: Richard S. White, Pres.; George F. Hawley, V. P.; John W. Sheppard, V. P.; Allen Howell, Sr. Stf. Engr.; Herman Baer, Ch. Engr.; Ray Long, Control Engr.

AUTOMATION INDUSTRIES, INC., Cockeysville, Md. **440**

AUTONETICS, A DIV. OF NORTH AMERICAN AVIATION, Bellflower, Calif. **134, 135**

Exhibiting: Inertial navigation systems; flight control systems; armament control systems; airborne Instrumentation; digital and analog computers.

In attendance: D. D. Acker, Asst. to Mgr. App.; W. R. Rishebarger, Gen. Supvr., Art & Publications; R. F. Geiger, Chf. App. Engr., Computers & Controls; H. M. Smith, App. Engr., Special Products; B. Van Houten, Customer Relations Rep., Fire Control Systems; L. J. Singleton, Customer Relations Rep., Inertial Navigation Systems.

AXLER ASSOCIATES, INC., Corona 68, L. I., N. Y. **168**

Exhibiting: New Products—Spectroscopic Analyzer & Processor; Optical Linear Wedge Filters; Interference Transmission Filters; Photo-Multipliers.

THE BAKER COMPANY, INC., Maplewood, Maine **408**

Exhibiting: New Products—Ultrasonic Cleaner—Models GW-4, GW-5; Air flow Ball Bearing Torque Tester; Instrument Ball Bearing Tool Kits. **Regular Products**—Sterilshield pressurized dust-free workspaces; torque tester and comparator; ball bearing torque tester.

In attendance: A. K. Baker, Pres.; E. M. Baker, V. P.; Frank A. Potenzo, Design Engr.; Malcolm Parsons, Instr. Frmn.; Joseph Feeley, Purchasing; B. J. Baker, Receptionist.

E. W. BALLOU, Trenton 2, N. J. **132**

Exhibiting: products of Heinemann Electric Co.

BALDWIN-LIMA-HAMILTON CORP., ELECTRONICS & INSTRUMENTATION DIV., Waltham 54, Mass. **542**

Exhibiting: Electronic systems and instrumentation for automation process control; Torquemeters and torque transducers; Load and pressure transducers.

In attendance: Howard Nielsen, Sls. Prod. Mgr.; Jim Howard Appl. Engr.; Samuel Ochlis, Sls. Prom. Mgr.; Al Shore, C. T. Moyer, J. Strickland, L. Moffett, R. M. Stuart, R. M. Kinney, Sls. Engrs.

BARNES DEVELOPMENT COMPANY, Lansdowne, Pa. **307**

Exhibiting: New Products—Sorting bridge for "multiple-class" sort of resistors; sorting mechanisms; **Regular Products**—Data recorder; deviation bridge; sorting bridge.

In attendance: George W. Barnes, Pres.; Edward N. Osten, Elec. Engr.; Raymond E. Fannestock, Designer.

BECKMAN INSTRUMENTS, INC., DATA & CONTROL SYSTEMS DEPT., Fullerton, Calif. **315**

Exhibiting: New Products—Model 112 Automatic Data System which measures, monitors, and processes data automatically; features new components; "Madic" magnetic digital control logic, transistorized analog-to-digital converter, transistorized preamplifier.

In attendance: Frank Scheufele, Sls. Mgr.; Hank Stover, Sls. Engr.; Taylor Fletcher, Mgr. of Data and Control Sys. Dept.; Larry Silva, Dir. Res. & Dev.; Howard Preston, Les Chapin, Engrs.

BELL AUTOMATION CORP., subsidiary of Bell Aircraft Corp., Rochester 7, N. Y. **306**

Exhibiting: "Electro-Way" products.

In attendance: F. S. McCullough, Gen. Mgr.; Ed F. Dunford, Sls. Mgr.; Donald B. Ladd, Bradley C. Gardner, Sls. Engrs.; Thomas Goslin, Ch. Engr.

BENDIX COMPUTER DIV. OF BENDIX AVIATION CORP., Los Angeles 45, Calif. **424**

Exhibiting: New Products—G-15D general-purpose digital computer with a DA-1 digital differential analyzer accessory which enables G-15D to perform as general purpose machine, and as dda. **Regular Products**—Magnetic-drum recording heads.

In attendance: O. P. Staderman, Dir. of Mktg.; R. A. Sweet, Eastern Reg. Mgr.; V. A. van Praag, Western Reg. Mgr.; R. E. Walz, So. Western Reg. Mgr.; H. Doyle, Mathematician; F. Adair, Customer Serv. Mgr.; W. J. McGuckin, Adv. Mgr.

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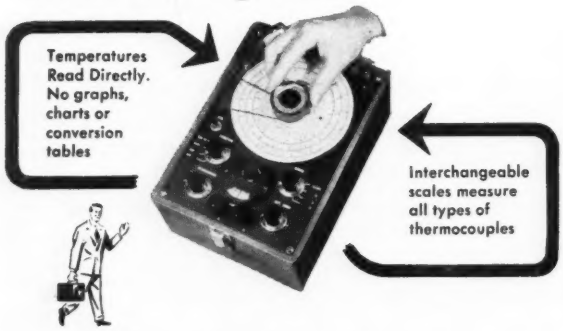
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EXHIBITORS, PRODUCTS—CONTINUED

BERKELEY DIV., BECKMAN INSTRUMENTS, Richmond 3, Calif. 315

Exhibiting: New Products—Model 1132 Computer; Model 5692 Digital Flow Indicator. Regular Products—Models 5840 Dual Preset Controllers; Model 7650 Events-per-unit-time meter; Operational Amplifiers; Electronic Multipliers; Servo & Automatic set-up Function Generators; Servo Multipliers and Resolvers; Servo and Automatic set-up Coefficient Potentiometers.

In attendance: John McWaid, Systems Engr.; J. L. Hussey, Mgr. Computer; C. D. Finnell, Sls. Mgr., Computer; D. R. Miller, Sr. Computer Engr.; R. C. Schmidt, Sr. Production Engr.; K. E. Sterne, Appl. Engr.; A. B. McLane, Sr. Engr.

BJ ELECTRONICS, BORG-WARNER CORP., Santa Ana, Calif. 138

Exhibiting: New Products—Digital pressure transducers and system components to indicate, record and control differing physical parameters in chemical processing plants, nuclear power, aircraft and missile telemetering applications, and in jet and reciprocating engine testing. **Regular Products**—UHF and VHF signal generators; slotted lines; incidental frequency-modulation meters; r-f wattmeters.

In attendance: John R. Harkness, V. P.; Grant Corby, Sls. Engr.

NORMAN BRAGAR CO., INC., Newark 2, N. J. 340

Exhibiting Products of: West Instrument Corp., Conax Corp., Ultradyne Engineering Labs., Inc., Hope Electrical Products Co., Inc., Scam Instrument Corp.

In attendance: Norman H. Bragar, Pres.; Mandell Dalis, George T. Reed, William J. O'Connor, Sls. Engrs.

BRANSON ULTRASONIC CORP., Stamford, Conn. 548

Exhibiting: New Products—"Sonogen" ultrasonic generators: Model AP-10B—small compact for bench-top washing of delicate parts; Model AP-25B—for production cleaning of small parts also for experimental work with ultrasonics; Model APT-100—for production cleaning of small and medium sized parts and pilot investigations of ultrasonic processing applications. "Vidigage" Model 14 non-destructive thickness gage. **Regular Products**—Transmission tester, coating-thickness and thickness gages.

In attendance: N. G. Branson, Pres.; P. K. Bloch, Sls. Mgr.; F. W. Hightower, Appl. Engr.; K. P. Hayes, M. Tamas, H. Biagini, E. Varrichio, Sls. Engrs.; W. Bleistein, W. Cronin, R. V. Harris, E. Harris, Engrs.

BRISTOL COMPANY, Waterbury 20, Conn. 301

Exhibiting: New Products—Syncroverter Choppers; Electronic Components; Recording, Automatic Controlling, and Telemetering Instruments; and Socket Screws.

BROOKS ROTAMETER CO., Lansdale, Pa. 532

Exhibiting: New Products—Transi-Twins Pneumatic and Electric Transmitters for use with Brooks Rotameters. Interchangeable units simplify standardization. Transmitter design is repleat with important features affecting in-the-line performance. Regular Products—Complete line of Rotameters.

In attendance: D. N. Brooks, Pres.; N. S. Brooks, V. P. Prod.; S. Blechman, V. P. Sls.; J. T. Aldrich, Appl. Engr.; H. F. Lorence, Adv. Mgr.

BURNDY CORPORATION, Norwalk, Conn. 422

Exhibiting: New Products—"Termatic" automatic machine for terminating continuous strip terminals (6000 terminals per hour); "Sealink" insulated, watersealed splice; "Uniring" one-piece, insulated ferrule for shielded or coaxial cable. **Regular Products**—Bandolug Machine; Insulugs; Hylugs & Hylinks; Nyloclips; Paneloks; installation tooling (hand, hydraulic & pneumatic); connectors for Magnetwire; Unilok gang disconnect panel.

In attendance: S. Bergman, Sls. Mgr., Omaton Div.; A. Aune, OEM Sls. Mgr.; H. Buttner, Military Products Sls. Mgr.; J. Lambert, E. Valehrach, OEM Fld. Engrs.; F. March, Mil. Prod. Sls. Engr.; T. Nestler, Aircraft Sls. Engr., L. Gage, Ad. & Sls. Prom, Mgr.; A. Butkowsky, Asst. Ad. & Sls. Prom. Mgr.; G. Singer, Ad. & Sls. Prom., Omaton.

JOHN CHATILLON & SONS, New York 38, N. Y. 316

COBEHN, INC., Caldwell, N. J. 531

Exhibiting: New Products—Cobehn long-nozzle sprayer for use with Spray-Clean Solvent for the precision cleaning of open relay contacts in computers and other assembled electronic and electro-mechanical components; automatic sprayer for production line cleaning of instrument bearings, jewel bearings, electrical contacts, semiconductors, and other precision electronic and electro-mechanical components. **Regular Products**—Cobehn High-Velocity Spray-Clean Equipment; Spray-Clean Solvent.

In attendance: George L. Henzel, Ch. Engr.; William E. Bellars, Sec.-Treas.; David F. Cook, V. P.-Sls.

COLEMAN ENGINEERING CO., INC., Los Angeles 16, Calif. 122

Exhibiting: Oscillogram Reader to convert oscillograph data into punched tape records for input to computers, as well as type D data for immediate reference. **Regular Products**—Decimal Digitizers; Binary and Binary-Coded Decimal Digitizers,

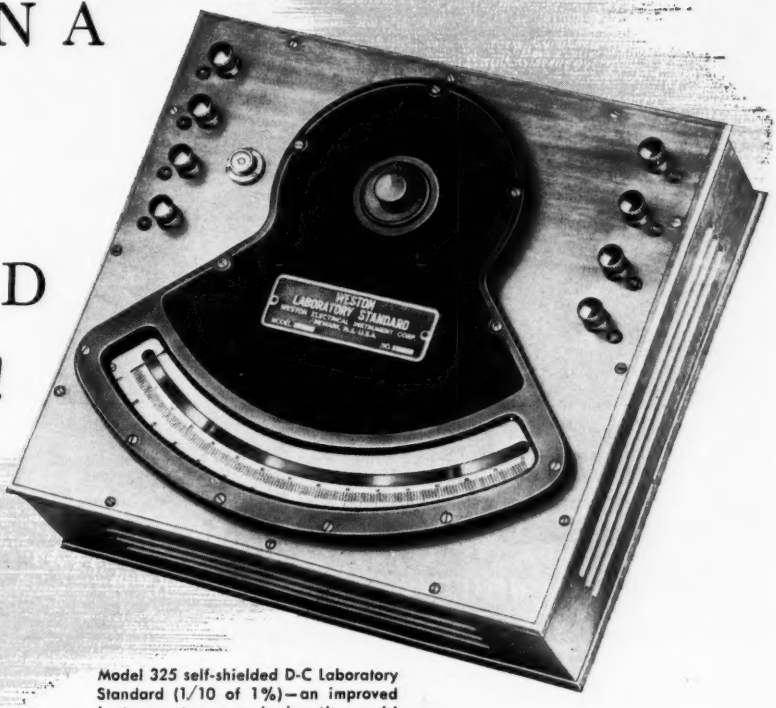
In attendance: Allen J. Edwards, Std. Prod. Mgr.; Neal D. Richards, Clay Anderson, Liaison Engrs.; Roy M. Knox, Supr. Elec. Engrg.; J. Albeck, Proj. Engr.

COMPUTER CONTROL CO., INC., Wellesley 57, Mass. 419

Exhibiting: New Products—Transistorized low-speed computer packages—flip-flops, multivibrators, diode gating structures, etc. **Regular Products**—3C-BLOC and 3C-PAC Digital Building Blocks.

In attendance: Robert W. Brooks, Pres.; William Wolfson, Dir. of Sls.; Robert E. Michaud, Appl. Engr.

NO MEASURABLE ERROR IN A 5 OERSTED FIELD!



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The new Weston model 325 provides a new STANDARD of laboratory measurement

Another WESTON first... a self-shielded primary instrument standard that is unaffected by magnetic fields normally encountered in the modern laboratory. While the new Model 325 incorporates a special CORMAG® mechanism, the overall design provides an even far greater degree of shielding than that inherent in the basic core-magnet mechanism. In fact, tests show absolutely no measurable error in a 5 oersted field. Thus there is no need for positioning or mounting the instrument with reference to the earth's field; nor to take undue precautions when using it in close proximity to current carrying conductors. In addition, Model 325 is well compensated for normal room temperatures; and a vernier type corrector is provided for precise and rapid zero adjustment. This improvement in primary instrument standards is another example of the *forward thinking* and *continuous development* which have kept WESTON the instrument leader since 1888. For complete data on Model 325, or on other Weston instruments consult your nearest Weston representative, or write... *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.* A subsidiary of Daystrom, Incorporated.

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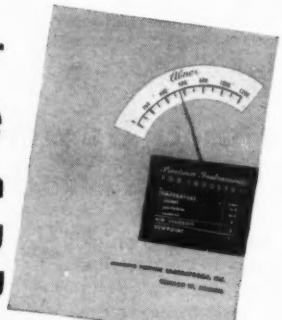

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EXHIBITORS, PRODUCTS—CONTINUED

CONDENSER PRODUCTS CO. DIV., NEW HAVEN CLOCK & WATCH CO., New Haven 4, Conn. **539**

Exhibiting: New Products—Uncased mylar and polystyrene capacitors, bakelite uncased polystyrene and mylar capacitors, high temperature teflon capacitors up to 200 deg. C. **Regular Products**—ASC Plasticon, AOC Plasticon, LSG, PAG, PAC, high voltage d-c power supplies.

In attendance: Richard J. Hesse, Sls. Mgr.; Herbert A. Haworth, Gen. Mgr.; James R. DeSanty, Sls. Engr.; John J. Ahearn, William Gentry, Thomas Murphy, Robert Shine, Engrs.

CONTINENTAL ELECTRIC CO., Chicago, Ill. **546**

COPY-CRAFT, INC., New York 7, N. Y. **327**

Exhibiting: "Ormig" Selective Data Printers for automatic selection of information from one master to be printed on single item tickets.

In attendance: J. H. Smith, Jr., Exec. V. P.; Ray Tompkins, E. M. Simon, W. L Raub, Ormig Systems Engrs.; Herbert Arndt, Chicago Rep.

COUNTER AND CONTROL CORP., Milwaukee 19, Wis. **423**

Exhibiting: New Products—ACRATROLS—Preset, electric counters with settings limited to round numbered multiples useful in general purpose counting applications. **Regular Products**—Cyclo-Monitors; Programonitors.

In Attendance: Harold J. Geder, Gen. Mgr.; Otto W. Riebe, Sls. & Serv.; Tony Dolan, D. C. Keaveney, H. E. Meader, Sls. Engrs.

COURTNEY AND COMPANY, Philadelphia 3, Pa. **522**

Services: Human Factors consulting and research services as applied to systems analysis (operations research), human engineering (man-machine design), environmental research (workspace layout, personal equipment design), product design based on consumer requirements, and personnel planning.

In attendance: Kenneth Colman, Sr. Res. Assoc.; George Rowland, Fld. Dir.; Douglas Y. Cornog, Res. Assoc.; Elizabeth Bowman, Administrative Asst.; Nannette Menneti, Res. Asst.

CRAWFORD FITTING CO., Cleveland 10, Ohio **502, 524**

Exhibiting: New Products—Swagelok: to Butt Weld Male Connectors; to Socket Weld Unions; to Butt Weld Elbows; to Socket Weld Elbows. New Line of Socket Weld Fittings; Swagelok Bulkhead adapter. Regular Products—Swagelok Tube Fittings: connectors, elbows, tees, unions, adapters, inserts, plugs, caps, reducers, quick connect fittings and thermocouple style male connectors in all machinable metals and plastics; Good Thread Lubricants.

In attendance: F. A. Lennon, Pres.; A. P. Lennon, Treas.; D. P. Haag, Sls. Mgr.

DAGE TV DIV., THOMPSON PRODUCTS, INC., Michigan City, Ind. **130, 131**

Exhibiting: New Products—Data-Vision— "Slow Sweep System" for data or informational material transmission utilizing 8-kc balanced telephone lines. **Regular Products**—Closed circuit cameras with remotely controlled lens turrets, pan and tilt, optical focus, iris and automatic iris; dustproof, weather-proof and explosion-proof housings; binary-type synchronizing generators, video monitors, color cameras and monitors.

In attendance: J. L. Lahey, Gen. Mgr.; John R. Howland, Gen. Sls. Mgr.; J. E. Campbell, Indust. Sls. Mgr.; J. Banister, Systems Engr.; Donald F. Pitts, Dist. Mgr.

DESIGN TOOL CORP., New York 6, N. Y. **516**

DETROIT CONTROLS CORP., Detroit 8, Mich. **346**

Exhibiting: Precision snap switches; mercury-jet switches, automatic pressure and temperature controls.

DIALIGHT CORPORATION, Brooklyn 37, N. Y. **140, 141**

Exhibiting: New Products—Oil-tight, water-tight, dust-tight indicator lights with neon and incandescent lamps for heavy duty industrial applications made to withstand severe shock and vibration. Regular Products—Warning, signal, pilot light assemblies.

In attendance: R. E. Greene, J. Weil, Vice Presidents; M. Greene, G. Weil, Sales.

THE HENRY G. DIETZ CO., Long Island 2, N. Y. **318**

Exhibiting: New Products—Cat. 200 Timed Operations Pre-selector—a multiple-circuit time control apparatus where each time interval is independently and individually adjustable with means for selecting a sequence or cycle of programmed events. **Regular Products**—Air flow switches; sensitive static pressure controls; manometers; timers; vacuum switches.

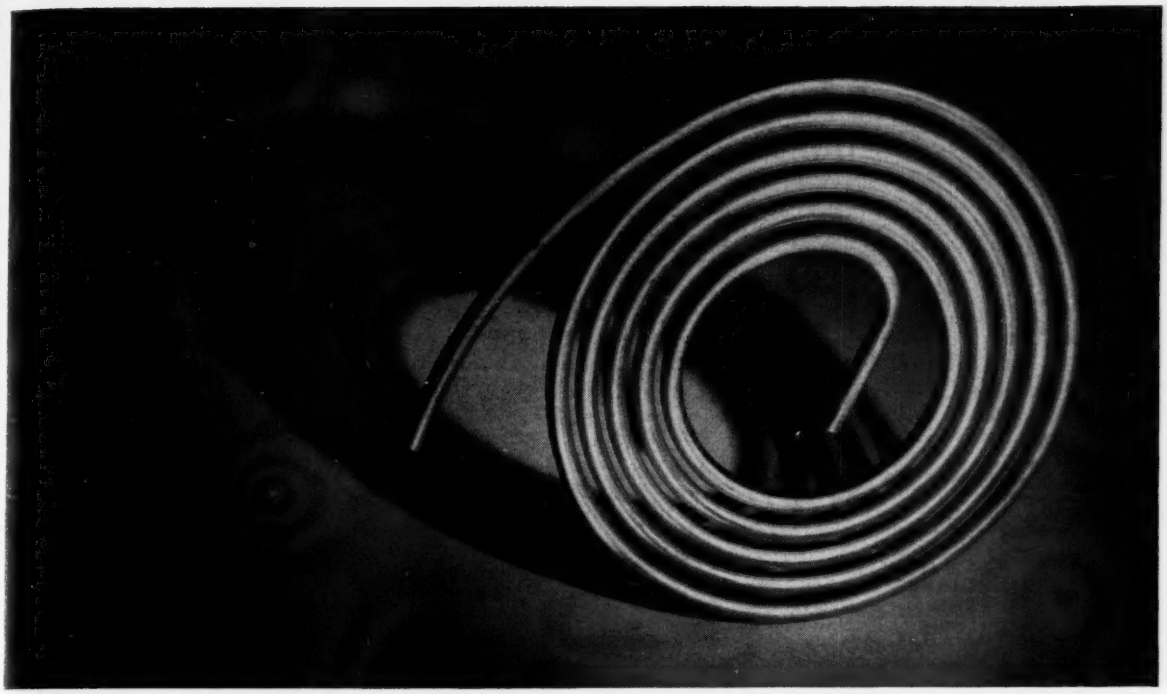
In attendance: Henry G. Dietz, Pre. & Ch. Engr. Carl F. Hayden, Chicago Sls. Rep.; Gordon Pheasey, John Karman, Jr. Engrs.; Madeline Pheasey, Sec.

DOELCAM DIV., MINNEAPOLIS-HONEYWELL REGULATOR CO., Boston 35, Mass. **125**

Exhibiting: New Products—A variety of electromechanical-devices for industrial and military applications.

ALLEN B. DU MONT LABS., INC., Clifton, N. J. **339**

Exhibiting: Cathode-ray instruments and associated equipment: industrial television.



Superior offers the widest range of sizes and alloys in top quality instrument tubing

Superior Tube Company produces the finest instrument tubing in a wide range of sizes and alloys—offers you as standard products what many makers would classify as specialty tubing.

1. NEEDLE TUBING

The stainless steel links in this recording instrument are made of Superior needle tubing. The high strength, stiffness, and strict dimensional tolerances characterizing this tubing—originally designed for surgical uses—have opened new fields of industrial applications when used as mechanical tubing.

2. PRESSURE AND SUPER PRESSURE TUBING

A spiral windpipe made of Superior 304 cold-drawn seamless stainless steel tubing. Pressure tubes are used to convey fluids at elevated temperatures and pressures. Produced in stainless, carbon and alloy steels in sizes to withstand pressures up to 100,000 psi.

3. BOURDON TUBING

A "C" tube element for a pressure gage. The shaped Bourdon tube serves as the actuating element for the majority of pressure indicating and recording instruments. Helix and spiral elements are also fabricated from the wide range of alloys available at Superior—a range that makes it possible to satisfy any set of conditions in the use of Bourdon tubing.

4. CAPILLARY TUBING

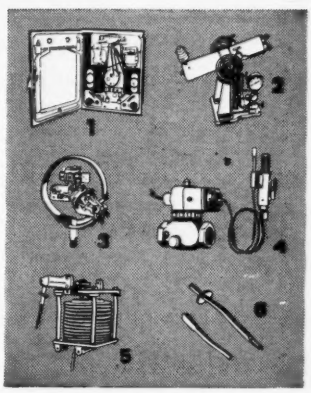
A thermostatic instrument pressure transmission element with a coiled unit made of Superior Type 321, capillary tubing. Superior capillary tubing is used primarily for transmitting temperature and pressure impulses from the source to a recording or indicating instrument. Capillary purposes, in general, require a heavy-wall tube with an ID of .006" to .030". Types 347, 321, 316, MONEL* and carbon steels are recommended analyses.

5. LARGE OD LIGHT WALL TUBING

A large OD light wall tubing bellows in a pressure actuating element. Present applications for large OD light wall tubing include bellows, low pressure heat exchanger tubes, flexible hose, aircraft ducting, fractional horsepower motor casings, ceramic drills, and casings for radioactive well logging instruments. Sizes offered up to 2½" OD.

6. MECHANICAL TUBING—INSTRUMENT LINE

Various fabricated parts—all made of Superior mechanical tubing. Superior mechanical tubing can be either seamless or WELDRAWN† grade used statically or dynamically, but not subjected to severe temperature or pressure. It is produced in sizes up to ⅝" OD within production limits, in many special shapes, and in over 63 standard analyses and mechanical properties.



Send for free copy of Bulletin 40—A Guide to the Selection and Application of Superior Tubing. Write Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

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On the West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif.

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Repeated, thorough tests reveal that IMPERIAL HI-DUTY FITTINGS can be assembled in 36% less time than regular COMPRESSION TYPE FITTINGS . . . and in 71% less time than FLARE TYPE FITTINGS. These are spectacular savings.

Fitting is furnished with integrated nut and sleeve assembled. To get a tight joint, simply insert tube into fitting and tighten nut. No loose sleeve to drop.

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ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

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EXHIBITORS, PRODUCTS—CONTINUED

DYNAMIC GEAR CO., INC., Amityville, N. Y. **504**
Exhibiting: Precision Stock and Custom Gears.

EASTERN PRECISION RESISTOR CORP., Richmond Hill 18, N. Y. **137**
Exhibiting: Wire-wound resistors; plastic compounds; automatic devices.

EDIN COMPANY, Worcester 8, Mass. **345**
Exhibiting: Expandable oscillograph consolette with modular preamps and basic amplifiers; standard oscillograph console units; automatic waveform analyzer.

ELECTRIC AUTO-LITE CO., Toledo 1, Ohio **322**
Exhibiting: Recording thermometers, pressure gages, vacuum gages, compound gages.
In attendance: L. B. Murphy, Sls. Mgr.-Indust. Thermometer Div.; Tom Murchie, R. R. Hopkins, Dist. Suprvs.; Leo Kubiak Salesman.

ELECTRO SWITCH CORP., Weymouth 88, Mass. **417**
Exhibiting: New Products—Solenoid-operated rotary switches. Standard heavy-duty power switches arranged for remote or automatic operation by rotary solenoids. **Regular Products**—Rotary switches: Tap, selector, instrument, control, special purpose.
In attendance: T. K. Brydson, V. P. Sls.; R. E. Getchell, Ch. Engr.; S. C. Lukens, Sls. Engr.; B. H. Ahlers, R. D. Hobbie, J. E. Drake, Sls. Reps.

ELECTRODATA CORPORATION, Pasadena, Calif. **437**
Exhibiting: E101 Computer; High-Speed Printer; Datareader (Magnetic tape unit #544).

ELECTRO-TECH EQUIPMENT CO., New York 13, N. Y. **101**
Exhibiting: New Products—Non-rotable shaft air cylinders from 1" to 60" long; single acting cylinders to 3" stroke length. **Regular products**—Electrical measuring instruments and industrial control equipment including: timers, relays, variable voltage transformers.
In attendance: Arthur Prince, Gen. Mgr.; George Levine, Sls. Engr.

ELECTRONIC ASSOCIATES, INC., Long Branch, N. J. **349**
Exhibiting: New Products—PACE—Precision Analog Computing Systems and associated output equipment. **Regular Products**—Analog computers; Variplotters (plotting board); six-channel recorder.
In attendance: Robert L. Yeager, Eastern Sls. Mgr.; Norman Seiler, Walter Helbig, Edward Schneider, Sls. Engrs.

ELECTRONIC CONTROL SYSTEMS, INC., Los Angeles 25, Calif. **156, 157, 507**
Exhibiting: New Products—"Digimatic" all-decimal special-purpose computer and magnetic tape control for machine tools, with computer programming simplified so shop personnel can enter information directly from blueprint. Model C-100A Statistical Analyzer—for automatic production testing, incoming inspection, and automatic acceleration of statistical data—tests at speeds and accuracies not capable by human labor. **Regular Products**—Continuity tester; Histogram tabulator; amplitude discriminator; special equipment test sets.
In attendance: P. R. Engels, Mgr. Lab. Services; A. F. Brewer, Exec. V. P.; B. Elbinger, Mgr. Spec. Products; E. Hoo, T. Scuitto, W. Broadwell, Members of Technical Staff; E. Spandau, Mgr., Applications Engr.

ELECTRONIC PLASTICS CORP., Brooklyn 7, N. Y. **137**
Exhibiting: New Products—Dispenser for Thermosetting Resins—automatic dispensing machines for epoxides, polyesters, polyurethanes, etc. **Regular Products**—EP-Fome; EP-1014 high temperature epoxy; EP-450 coating compound; EP-223 high temperature modified polyester; encapsulated precision wire wound resistors.
In attendance: Martin Green, Pres.; Hal A. Salzman, Gen. Sls. Mgr.; Dr. B. G. Forman, Res. Dir.; Harvey Fried, Ch. Electronic Engr.; Joseph Sinacore, Sls. Engr.; Miss B. Rose.

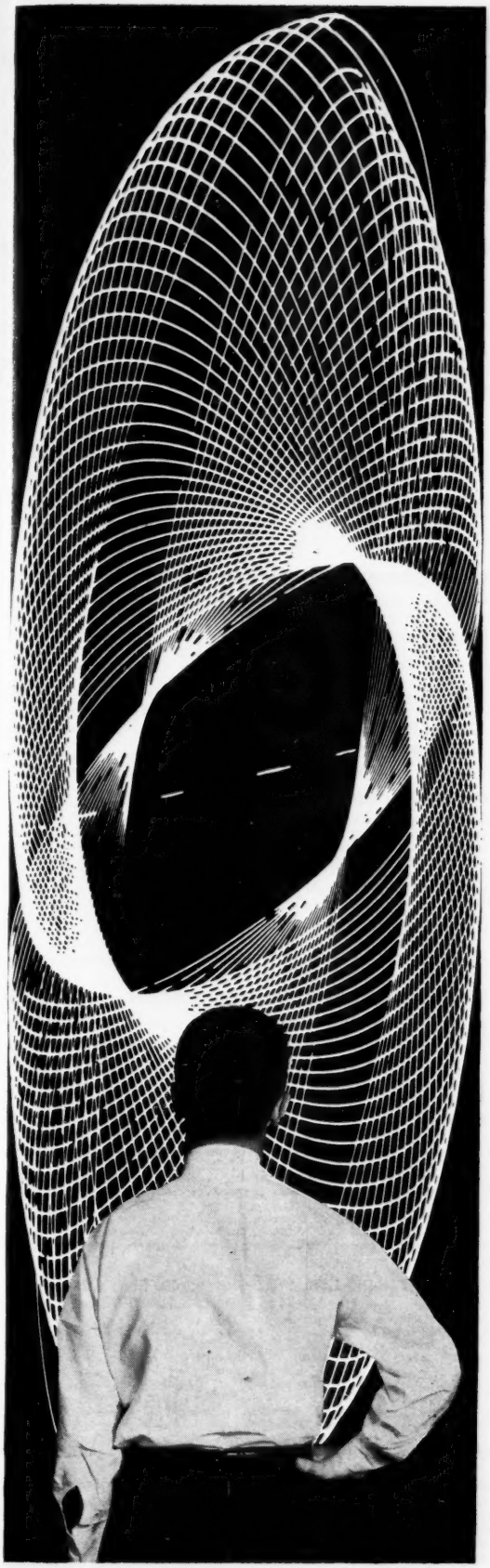
ELGIN METALFORMERS CORP., Elgin, Ill. **116, 117, 118**
Exhibiting: EMCOR Modular Enclosure System.

ELGIN NATIONAL WATCH CO., ELECTRONICS DIV., Burbank, Calif. **104**
Exhibiting: New Products—"Neomite Relay"—worlds smallest precision relay; "SN" series relay—high vibration type relay with extreme sensitivity; "VG" series relay—high shock & vibration resistance small size relay. **Regular Products**—Electrical relays.
In attendance: A. P. Barton, Gen. Mgr., Electronics Div.; E. C. Carlson, Sls. Mgr., Electronics Div.; F. S. Schaumburg, Sls. Mgr., West Coast Plts.; E. Firth, Relay Sls. Supv.; J. Krack, F. Winter, Sls. Engrs.

ENCYCLOPAEDIA BRITANNICA INC., New York 17, N. Y. **305**
In attendance: J. Wittchen, Mgr.; D. W. Wynkoop, Dist. Mgr.; R. Jacquemot, P. Banker, E. McGovern, Asst. Mgrs.; C. D. Griggs, Div. Mgr.

EPSCO, INC., Boston, Mass. **416**
Exhibiting: Data Processing Equipment & Control Instruments. High-speed analog-to-digital conversion equipment.

ERIEZ MANUFACTURING CO., Erie, Pa. **304**
Exhibiting: New Products—MAGNA-MOVER—a permanent magnetic conveyor-elevator, for magnetically moving all types of ferrous objects



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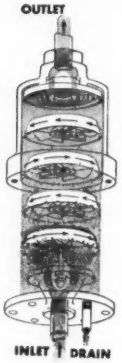
Learn how the engineered-to-your-line ARIDIFIER can solve your problem and save you trouble and money. Write for the Aridifier catalog.



Exploded view showing ARIDIFIER operation. Capacities, 7 to 17,000 C.F.M.

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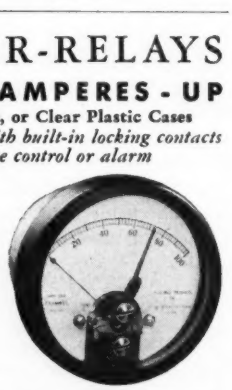
■ NEW METER-RELAYS

FROM 0-5 MICROAMPERES - UP

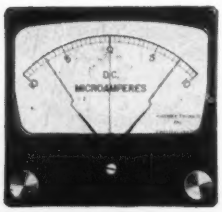
Ruggedized-Sealed, Black Bakelite, or Clear Plastic Cases

D'Arsonval indicating meters with built-in locking contacts for sensitive and accurate control or alarm

TRIP POINT ADJUSTABLE to any point of scale arc. Sensitive to changes as little as 1%. One contact carried on moving pointer. The other on an adjustable pointer. When two pointers meet, contacts close and lock. Holding coil is wound directly over moving coil, locking action is electro-magnetic. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully.



Model 255-C, Single Contact, High Limit, 0-10 Volts DC $42.50



Model 461-C, Double Contact 10-0-10 Microamps DC $83.25

Ranges from 0-5 microamperes or 0-5 millivolts up, full scale. Temperature ranges from 0-300°F. (10 ohms external) have bimetal cold junction compensation. **Standard Contact Rating** 5 to 25 milliamperes DC. Can be built up to 100 milliamperes DC.

Ruggedized-Sealed metal cases are 2½", 3½" and 4½" round, shock-mounted, gasket-sealed.

Black Bakelite case, 4½" rectangular.

Clear Plastic cases are 2½", 3¾", and 4½" rectangular. Maximum visibility and lower cost.

Panel meters and indicating pyrometers are also available in ruggedized-sealed, black bakelite or clear plastic cases. New 40-page catalog lists prices and specifications for meter-relays, meters, pyrometers and automatic controls using meter-relays. Write for Catalog 4-A, **Assembly Products Inc., Chesterland 10, Ohio.** HAmilton 3-4436 (West Coast: Desert Hot Springs 10, Calif. Phone: 4-3133 or 4-2453)

For more information circle **85** on inquiry card.

EXHIBITORS, PRODUCTS—CONTINUED

—nuts, bolts, nails, spikes, stampings, metal parts, finished products, cans, caps, etc.; MAGNA-RAILS-permanent non-electric magnetic elements for existing conveyor belts (directly under belt) or incorporated in new lines; HI-VI electro permanent magnetic vibratory feeders to feed and accurately control bulk materials. **Regular Products**—Small diameter magnetic rolls, control plate magnets, magnetic tubes, "V" groove magnetic rolls.

In attendance: R. A., Roosevelt, Sls. Mgr.; M. L. Cramer, Chf., Sls. Eng'ng. Section; Ned Hirt, Adv. & Prom. Mgr.; Jos. F. Kern, John Signafoos, Sls. Reps.

FAIRCHILD CONTROLS CORP., COMPONENTS DIV., Hicksville, N. Y. **308**

Exhibiting: New Products—High Temperature Precision Potentiometers—150 deg. C. wire-wound linear and functional, single and multi-turn types. Pressure Transducers—2" and 3" with single or dual potentiometer outputs; linear or functional outputs available. Sine-Cosine Potentiometers—available in three diameter sizes: 3", 2" and 1¼". 10-Turn Potentiometers (⅞")—resistance range 100 to 100,000 ohms; linearity values as low as 0.25%. **Regular Products**—Precision potentiometers; FilmPots and FilmPot trimmers; pressure transducers, and other components.

In attendance: A. A. Budde, Sls. Mgr.; R. J. Sullivan, Chf. Dev. Engr.; F. C. Weiss, Jr., Sls. Prom. Mgr.; R. Glueck, H. McCann, H. Cashman, E. Breen, H. Avey, Sls. Engrs.; E. Roman, C. Waterman, J. Dougherty, M. Christenson, L. Van Eperin, Sls. Liason.

FALSTROM CO., Passaic, N. J. **448**

Exhibiting: New Products—Control boxes, panels, consoles and cubicles. **Regular Products**—Custom-built panel boards, control boxes, consoles, cubicles, and cabinets, relay racks, frames, mountings and stands.

In attendance: M. C. F. Lindholm, Pres.; A. W. Lindholm, V. P.; W. Ricker; C. F. Lindholm II; R. E. Hill, Sls. Mgr.; W. H. Muench, Estimator; J. E. Jensen, J. Santhouse, Sls. Engrs.

FARRAND CONTROLS, INC., New York 70, N. Y. **112, 113**

Exhibiting: New Products—Inductosyn Automatic Control Systems for machine tools and military devices. **Regular Products**—Optical tooling instruments and accessories.

In attendance: R. W. Tripp, Ch. Engr.; J. L. Winget, Ch. Electronics Engr.; V. Foster; W. Grace, Electronics Engrs.; D. A. Korman, Sls. Mgr.; C. L. Farrand, Jr., Asst. Sls. Mgr.

FEMCO, INC., Irwin, Pa. **160**

Exhibiting: New Products—Remote Control and Indication, Carrier and Audio Communications.

FISCHER & PORTER CO., Hatboro, Pa. **430, 444**

Exhibiting: Data Reduction and Automation Systems.

FREED TRANSFORMER CO., INC., Brooklyn 27, N. Y. **133**

Exhibiting: New Products—Electronic counters; magnetic amplifiers; portable megohmmeter. **Regular Products**—Transformers, reactors, toroid inductors; filters, magnetic amplifiers; ultrasonic components; and laboratory test equipment.

In attendance: M. Salzberg, Sls. Mgr.; G. T. Dalrymple, Engr. Inst. Div.; F Wolfe, Engr Inst Div; R M O' Dea, Sls. Engr.; L. Freed, Pres.; D. Gurevics, Ch. Engr.; S. Solzberg, Engr.; J. Solzberg, Sec.

GAP INSTRUMENT CORP., Valley Stream, N. Y. **404**

Exhibiting: New Products—Step Motors; Step Transmitters; Differentials; Mechanical Integrator; Analog to Digital Converter; Precision Gears.

GAUDREAU, RIMBACH & ASSOCIATES, Pittsburgh 12, Pa. **409**

Services: Plant layout; material handling; production controls; cost controls; punched-card systems.

In attendance: A. T. Gaudreau, Partner, N. Y. City; R. W. Mallick, Partner, Pittsburgh, Pa.; Frank Schneider, Midstates Dist. Mgr. Milwaukee, Wis.; Mrs. S. F. O'Gorman, Receptionist.

GENERAL MILLS, INC., MECHANICAL DIV., Minneapolis 13, Minn. **150, 151**

Exhibiting: New Products—"Autofab" Short Run Assembly Machine—a flexible semi-automatic bench-mounted machine for mounting electronic components in printed circuits, rapidly and with uniform quality. "Autofab" Soldering Machine—a bench-mounted machine for semi-automatically dip soldering printed circuits with precise control of time and solder level and temperature.

In attendance: Albert B. Driscoll, Dir. of Equip. Sls.; Paul Peterson, Dev. Engr.; Edmund E. Johnson, Adv. Mgr.; Arthur A. Brevaire, Asst. Eastern Regional Sls. Mgr.; John Roegge, Asst. to Dir. of Equip. Sls.

GENERAL PRECISION LAB., INC., Pleasantville, N. Y. **108-111, 325**

Exhibiting: New Products—Ruggedized television camera, Model PD-152 to operate under extreme vibration, noise, shock, and environmental conditions. **Regular Products**—Industrial and institutional television systems, cameras, camera control units, camera switchers, monitors, television projection systems, remote control equipment, etc.

In attendance: Dr. Raymond L. Garman, V. P. and Managing Dir.; Blair Foulds, V. P.; Nat Marshall, Sls. Mgr.; S. L. Thomas, N. Y. District Sls. Mgr.; Norman Wicks, Mgr.—Institutional Television; A. F Brundage, Mgr.—Shows aand Exhibits; E. J. Manzo, Eastern Reg. Mgr.; E. K. Price, H. L. Ryder, J. P. Webster, Sls. Engrs.; J. W. Mullen, Mid-Atlantic Dist. Sls. Mgr.; J. W. Belcher, Mgr.-App. Engr.; A. G. Balletta, F. R. Pike, L. P. Winship, App. Engrs.

GERBER SCIENTIFIC INSTRUMENT CO., Hartford 3, Conn. **337**

Exhibiting: New Products—"Equameter" used for determination of Fourier series, power series, least squares from plotted or recorded curves or test points. **Regular Products**—Variable Scale; Graphanalogue; Derivimeter-Data Reduction units.

In attendance: H. Joseph Gerber, Pres.

KLEINSCHMIDT LABORATORIES

joins hands with

SMITH-CORONA INC

. . . to pioneer new developments in Printed Communication and Electronic Data Processing

KLEINSCHMIDT LABORATORIES – the *foremost* name in printed communication – has recently merged with Smith-Corona Inc itself a famous pioneer in the manufacture of superior typewriters.

The products of each of these companies stand unsurpassed for advanced design and fine performance.

Smith-Corona is a national leader in the production of quality typewriters – portable, standard, and electric – as well as highly-efficient adding machines and cash registers. For many years, Kleinschmidt has been a leader in the printed communications industry with a broad line of high-speed, lightweight, telegraphic communications equipment.

These fine products will of course continue to be marketed. But more important, these two already forward-looking companies–Kleinschmidt and Smith-Corona – will pool their resources to make new advances with new products in new fields.

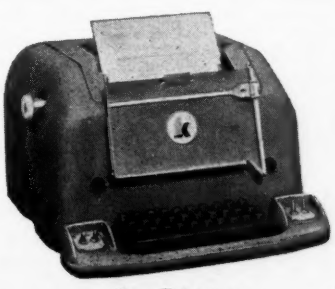
Such advances may be expected in the fields of electronics and integrated data processing – the rapid reproduction and transmission (for one example) of such business information as sales orders, shipping data and other communications.

Together, we face eagerly the opportunities of the future – just as we recollect with pride our contributions of the past.

KLEINSCHMIDT

. . . the foremost name in printed communications

A SUBSIDIARY OF SMITH-CORONA INC



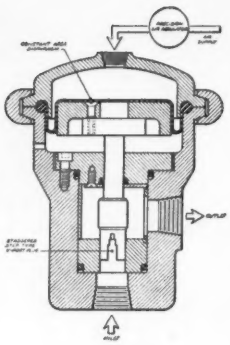
Page Teleprinter

Tape Transmitter

Typing Reperforator and Tape Transmitter

For more information circle **86** on inquiry card.

COMPLETE BACK PRESSURE CONTROL SYSTEM



This sectional drawing shows the design and construction of our novel Micro Delta P Controllers. When used with a regulated air supply, they provide a complete back pressure control system. A Micro Delta P Controller maintains a constant pressure on the discharge side of a non-pulsing hydraulic system by throttling the flow from the hydraulic power source at any flow rates within its range.

A significant feature of the Controller is the constant area, rolling type diaphragm. Use of it results in linearity between the loading pressure and the controlled back pressure. This construction, as opposed to piston type actuator, also provides greater sensitivity and repeatability with minimum hysteresis.

Micro Delta P Controllers have been used for many purposes such as the maintaining of a constant upstream pressure from the discharge of test pumps, and as controllers for hydraulic dynamometers. Two Micro Delta P Controllers used together can provide preset and intricate loading patterns for various types of actuator testing.

Write for our new bulletin, No. 544 which gives complete details and shows suggested schematic flow diagrams.

INDUSTRIAL IEC ENGINEERING CORP.

INDUSTRIAL ENGINEERING CORPORATION

525 E. Woodbine, Louisville 8, Ky.

For more information circle **87** on inquiry card.

Sapphire Wear Part shown here is from a Hook-forming Gear at the Westinghouse Lamp Division, Bloomfield, N. J.

Sapphire Insert Cuts Costs 85%

for Westinghouse Lamp Division—and they write us:

"The use of the sapphire at the critical wear point has drastically reduced the wear problem, for the Forming Gears with inserts outlast the gears without inserts at an average ratio of 10:1. Using a sapphire insert in the gear has meant an 85% reduction in the yearly cost of this item in addition to reducing expensive machine downtime."

If you have a friction or wear problem that means frequent replacement of close-tolerance, expensive parts such as this, send for an analysis by our engineering staff . no charge, of course. Other typical solutions are illustrated in our brochure . . . send for it today!

aurele m. gatti inc.

"Precision Sapphire Products Miniature Sub-Assemblies"

Main Office and Factories — 526 Tindall Ave., Trenton, N. J.
Manufacturing Subsidiary — Guayama, Puerto Rico

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EXHIBITORS, PRODUCTS—CONTINUED

GORN ELECTRIC CO., INC., AIRCRAFT CONTROLS CO., DIV., Stamford, Conn. **544**

Exhibiting: New Products—GAB1000—vacuum pressure switch (pressures to 2" Hg absolute); GHF5400—horizontal float switch (extends horizontally only 3" into tank at fluid control level); GPP12000—high pressure switch; GPI-2000—Line of miniature, industrial pressure indicators to operate signal lights, relays, or annunciators; GMRD Snap-Joc connectors;—GHRIF & M high temperature connectors. **Regular Products**—Pressure switches; dp switches; air-speed switches; Pin Type electronic and electrical connectors; printed circuit connectors.

In attendance: A. H. Morgan, Mgr. Sls. Engrg.; J. G. Dube, Sls. Dept.; A. Saraceno, Qual. Cont. Mgr.; O. Mueller, Chf. Engr. Aircraft Controls Co. Div.; L. Rumely, Asst. Div. Mgr. Electronics Div.; E. S. Cornell, Chf. Engr. Electronics Div.; M. Gorn, Pres., Gorn Electric Co.

GORRELL & GORRELL, Westwood, N. J. **510**

Exhibiting: New Products—Ten-in-One interval timer; multi-cam cycling timer; M-G cycling timers; operations recorder; recycling timer; instrumentation drives; one-way clutch; etc. **Regular Products**—Chartmovers; gear trains; charting papers.

In attendance: L. M. Gorrell, Pres.; Joseph Conklin, Plt. Mgr.; J. Gorrell, Dir.; Leo Bolet, Experimental Engr.

W. & L. E. GURLEY CO., Troy, N. Y. **401**

Exhibiting: New Products—Precision patterns on glass & metal; shaft digitizer; linear scales; linear and angular coincidence reading systems; circuit controlling anemometers.

HAMMARLUND MFG. CO., INC., New York 1, N. Y. **551**

Exhibiting: New Products—Centralized operations control "COC", equipment for telemetering, remote operation and remote supervisory control. **Services**—Systems engineering for utilities, refineries, pipe lines, railroads and heavy industry.

In attendance: F. F. Sylvester, Sls. Mgr.; L. C. Menkes, Asst. Sls. Mgr.; Stan Lescarboura, Adv. Mgr.; R. M. Daugherty, Dir. of Engrg.; A. M. Lerner, Section Chief; F. L. Peters, R. S. Pettigrew, R. E. Barnhill, Dale Cowan, Sls. Engrs.; Sue Montecalvo, N. Y. Off. Sec.

HANSON-GORILL-BRIAN, INC., Glen Cove, L. I., N. Y. **102**

Exhibiting: New Products—Modularized Industrial Automatic Data Logging Systems; Thyratron Circuit Components and Systems.

A. W. HAYDON CO., Waterbury 20, Conn. **330**

Exhibiting: New Products—Sub-miniature repeat cycle timer for d-c operation—one-third size and one-quarter weight of standard units; sub-miniature time delay relay; precision interval timer. **Regular Products**—D-c timing motors; 400-cycle, reversible 60-cycle timing motors; cycle timers; time delay relays; intervalometers; stop clocks.

In attendance: R. J. Harrant, Sls. Mgr.; R. W. Perkins, F. Hoffman, P. Famiglietti, G. W. Burns, J. A. Niekerk, A. N. Milliken, Sls. Engrs.

HEAT TIMER CORP., New York 12, N. Y. **139**

Exhibiting: New Products—Smoke Indicating Alarms; Recorder-Totalizers; Combustion Controls.

HEINEMAN ELECTRIC CO., Jersey City 6, N. J. **132**

Exhibiting: Circuit breakers and relays.

KARL HEITZ, INC., New York 17, N. Y. **505**

Exhibiting: New Products—ALPA single lens reflex 35mm camera featuring a ground glass **with clearspot** for microscopic photography at high magnification. **Regular Products**—Cameras, refractometers, spectroscopes, microscopes and accessories.

In attendance: Karl Heitz, Pres.; Marc Tobler; Helen R. Westerman.

GERALD K. HELLER COMPANY, Baltimore 23, Md. **411**

Exhibiting: New Products—CX25 motor controller—operates ¼ h.p. shunt-wound d-c motor on 115 volts a-c single phase.

In attendance: P. Cushing, Jr., Leo Fitz, Jr., H. W. Ruby, Sls. Reps.; G. K. Heller, Owner.

THE HICKOK ELECTRICAL INSTRUMENT CO., Cleveland 8, Ohio 144

Exhibiting: New Products—Cathode ray oscilloscope, Model 770; mutual conductance tube tester, Model 750. **Regular Products**—Electrical indicating instruments; electronic test equipment.

In attendance: R. D. Hickok, Pres.; H. D. Johnson, V. P.-Sls.; R. K. Arbogast, R. A. Underhill, K. E. Hughes, Fred Bush, Carl Quirk, Walter Boiko, Jack Jartley, C. E. Babcock, Sls. Engrs.

HILLYER INSTRUMENT CO., INC., New York 13, N. Y. **161, 520**

Exhibiting: New Products—Automatic locating and drilling machine; Multiple channel programmer; Transacter system.

HOLLIDAY-HATHAWAY CO., INC., New York 22, N. Y. **426**

Representing several precision component and equipment manufacturers.

In attendance: Dorothy I. Holliday, Pres.; Kenneth E. Hughes, Gen. Mgr.; Frank J. Stevens, Fred Bush, Eugene Dowd, George McCarthy, Tom McManus, Hal H. Everett, J. Doolittle, Lewis Carlan, Daniel Workman, David S. Launt, Richard Moran, James F. Newlon, Carl Quirk, Walter Boiko, Jack Hartley, Kelsey Martin, Chas. E. Babcock, Sls. Engrs.

Simplest pneumatic controller to use and maintain

Bristol gives you improved stability of control action —but keeps basic simplicity of Series 500 Controllers

Bristol Series 500 Pneumatic Controllers are the easiest controllers on the market to use and maintain—still the most dependable and trouble-free.

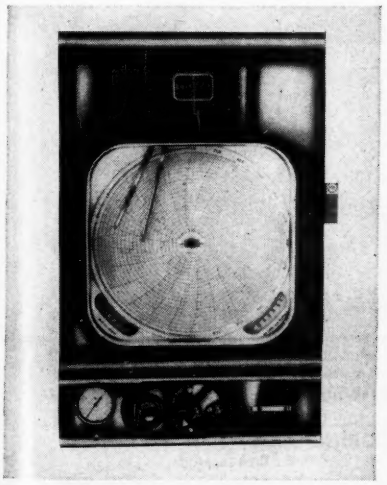
The reason? The basic simplicity of the operating mechanism. *That* hasn't changed in the years since we introduced this long-time favorite among instrument men. Reason No. 2: they are equipped with famous Bristol measuring elements.

Easy calibration

It's this foolproof simplicity of the control system that makes calibration so easy on Series 500 controllers. *Only one* service adjustment is required and provided to exactly calibrate the control system. The control system can be completely disassembled and after reassembly (even with replacement of parts) can be restored to precise calibration with this *one* adjustment.

No special tools are required. A ¼-inch wrench is all that's needed.

The 500's completely interchangeable parts, accurately designed and manufactured to extremely close tolerances, make possible this built-in calibration.



BRISTOL'S® SERIES 500 CONTROLLER, shown here with four-position transfer station. Internal station also available.

And check these features:

Improved control stability—advanced automatic control techniques have been applied by Bristol engineers to improve stability of control action in the new Series 500W Controllers.

Wide-band models offer choice of ½ to 400% proportional band with simple band shift.

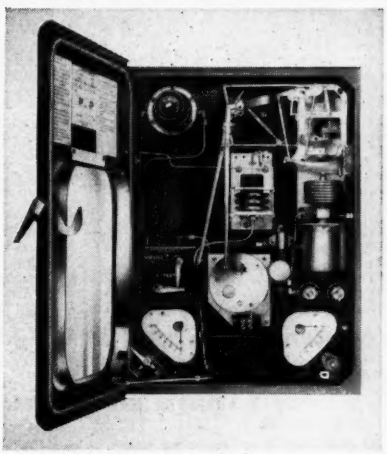
True zero derivative setting—exclusive with Bristol.

Reset action stops in reset models—again a Bristol exclusive—prevent loss of control due to prolonged deviation from set point.

Four-position internal transfer station with automatic, manual, test, and service positions, plus pressure-matching button and manual pressure regulator, for maximum convenience in process control.

Complete data available

Write today for engineering data on Bristol's Series 500 controllers for your critical control problems. They're available for *automatic control of temperature, pressure, vacuum, draft, absolute pressure, liquid level, humidity, pH value, electrical measurements, and mechanical motion.* The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



FOUR-POSITION INTERNAL TRANSFER STATION shown here in interior view of Series 500 Controller. Permits remote manual control, testing and servicing without disconnecting instrument.

YOU CAN GET THESE CONTROL MODES:

1. **Fixed narrow band (on-off)**
2. **Proportional band**—½ to 100% and ½ to 30%.
3. **Reset with wide band**—rates 0.1 to 10 or 1 to 300 repeats per minute. Proportional band ½ to 400%.
4. **Derivative (rate)**—½ to 100% proportional band. Derivative time 0.2 to 20 min., plus zero derivative setting.
5. **Reset plus derivative**—proportional band and reset rate as in "reset" above. Derivative time as in "derivative" above.

YOU CAN HANDLE THESE CONTROL PROBLEMS:

1. Cascaded control 2. Selective control 3. Ratio control 4. Time-program control 5. Pneumatic transmission.

6.55

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BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **89** on inquiry card.

EXHIBITORS, PRODUCTS—CONTINUED

HARVEY HUBBELL INC., Bridgeport, Conn. 523

Exhibiting: Wiring devices and interlock connectors.

HYCON MFG. CO., Pasadena 8, Calif. 136

Exhibiting: New Products—Digital Voltmeter with printout system, measures and records in one operation and produces permanent record—for production testing, inspection, research and development. Memory Delay Unit—produces delayed pulses for each received pulse, to operate Hycon aerial camera as part of UCCS. Hyconverter—transistor power supply to replace vibrators, inverters, and dynamotors from 15 watts to 1 kilowatt. **Regular Products**—VTVM; digital rack-mounted oscilloscope; color bar/dot generator; Universal Camera Control System.

In attendance: Ray D. Patton, Industrial Rels. Dir.; Don Downie, Public Rels. Dir.; E. J. Norman, Sls. Mgr. and Eugene DiSciullo, Sls. Rep., Hycon Electronics.

INDUSTRIAL TIMER CORPORATION, Newark 4, N. J. 508, 512

Exhibiting: New Products—Punched-card reading, controlling and timing equipment; multi-cam timer kit. **Regular Products**—Synchronous motor-driven timing devices; Interval, time delay, and single-cycle and repeat cycle multi-cam timers; running time meters; tandem recycling timers.

In attendance: R. A. Rossney, F. G. Corbutt, Bernard Volin, K. P. Kraemer, Div. Sls. Mgrs.; L. L. Neidenberg, Treas., Sls. Mgr.

THE INSTITUTE OF RADIO ENGINEERS, New York 36, N. Y. 105

Exhibiting: Publications of the IRE; membership information.

In attendance: Herbert A. White, N. Y. Dist. Mgr.; William C. Copp, Exhts. & Adv. Mgr.; Miss Lillian Petranek, Reservations Mgr.

INSTRUMENTS PUBLISHING COMPANY, Pittsburgh 12, Pa. 169, 170

Exhibiting: Publications—"Military Automation", "Instruments & Automation" and "Instrument & Apparatus News". Buying Directory—"The Instruments and Automation Handbook & Buyers' Guide" Books—"Process Control", "Nuclear Reactors for Industry and Universities", "The Automatic Factory", "The Computer Handbook."

INTERCONTINENTAL DYNAMICS CORP., Englewood, N. J. 427

Exhibiting: New Products—Sigmatron and Edgetrol—Electronic Test Equipment.

INTERNATIONAL BUSINESS MACHINES CORP., New York, N. Y. 348

Exhibiting: New Products—Time Equipment.

INTERNATIONAL STANDARD TRADING CORP., New York 6, N. Y. 527

Exhibiting: New Products—12 Point High-Speed Stepping Relay 7500/12. Regular Products—G10/241E Nomotron gas-filled decade counter; magnetic pushbuttons; intercommunication telephones; teleprinters and associated tape equipment; automatic, self-supervised pneumatic tube systems.

In attendance: J. T. Benjamin, V. P.; W. Stieber, Proj. Mgr.; F. Warden, Chf. Des. Engr.; E. M. S. McWhirter, Tech. Dir.; D. D. Bulkley, Sls. Engr.; H. J. Browne, A. Imbornoni, D. Morrison, Proj. Engrs.

JERROLD ELECTRONICS CORP., Philadelphia 3, Pa. 407

Exhibiting: New Products—(1) Wide Band Television Transportation System—Two channels of high definition video can be multiplexed on a single coaxial cable by use of FM carriers. 600 line pictures will be transported over this system consisting of FM modulators, demodulators, and wide band preamplifiers. (2) Sweep Generator, Model 900—a continuously variable sweep from 0.2 to 1000 mc center frequency. Sweeps widths, a spectacular 300 mc continuously variable down to 0.1 mc. **Regular Products**—Coaxial Cable fittings; RF testing equipment, Line Amplifiers; Distribution Amplifiers; Isolation Units and Matching Transformers.

In attendance: Robert N. Vendeland, Mgr., Indust. Sls. Div.; G. Worth Warnick, Chf. Fld. Engr., Sls. Div.; Max H. Kraus, Asst. to the Pres.; Don Kirk, V. P. Dir. of Res.; Ken Simons, Sr. Proj. Engr.; Walter Goodman, Mgr., Jerrold N. Y.; John Perry, Sls. Engr., Jerrold, N. Y.

KAYDON ENGINEERING, Muskegon, Mich. 137

KELLOGG SWITCHBOARD & SUPPLY CO., Chicago 3, Ill. 406

Exhibiting: Relays; counting unit.

In attendance: R. H. Williamson, Mgr. Indus. Sls.; J. A. Rudy, Mgr. Relay Sls; J. E. Boeing, J. Kitchen, J. Kaelber, P. Mack.

KLEINSCHMIDT, INC., Deerfield, Ill. 336

Exhibiting: New Products—Teleprinters.

KULKA ELECTRIC MFG. CO., INC., Mt. Vernon, N. Y. 314

Exhibiting: New Products—Miniature and sub-miniature terminal blocks. Development of new molded type of materials.

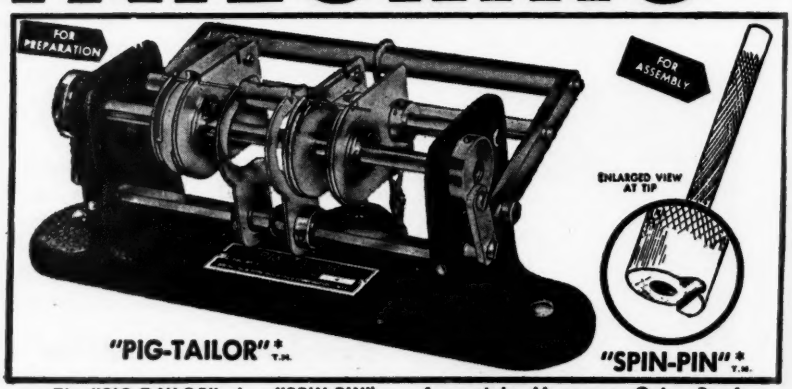
In attendance: Eugene R. Kulka, Pres.; William Kulka, Treas.; E Edelman, Sls. Mgr.; A. Friedman, B. Smith, George Antonion, Sls. Reps.

KYBERNETES CORP., New York 16, N. Y. 547

Exhibiting: New Products—Automatic data logger; scanning and annunciator equipment.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. IA-10P

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

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● A new dual-beam cathode-ray oscillograph with facilities for precise observation, comparison and measurement of two related a-c or d-c signals.

Has two complete vertical amplifiers with response flat to d-c and uniform within 30% to 300 kc. Amplitude measuring on both channels includes 16 ranges from 400 volts full scale to only 4 millivolts for full deflection to scale limits. The most sensitive range permits a-c or d-c measurements in the microvolt region. Balanced input is available on the seven most sensitive ranges.

High-level, accurate, calibrated, linear sweeps; automatic beam gate; sweeps range from 1 sec./inch to 2 usec./inch in 19 steps common to both channels.

X-amplifier provides up to 20 inches of undistorted sweep expansion; external horizontal input to either or both channels.

Observe, compare and measure two related AC or DC signals with the new, high precision

PRICE
$990.00

DU MONT TYPE 333
CATHODE-RAY OSCILLOGRAPH

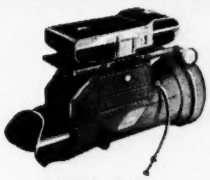
AND FOR THE RECORD...

TYPE 296

Versatile, economical 35 mm general-purpose oscillograph record camera with f/2.8 lens. Price $149.50

TYPE 299

General-purpose recording camera accepts variety of backs for 120 size roll film, cut film or film pack; inexpensively converted into print-a-minute Polaroid Land camera. Price $265.00



TYPE 302

For permanent records in just a minute with Polaroid-Land back; by simple, inexpensive change of backs can be adapted for general-purpose recording with other than Polaroid films. Price $285.00

TYPE 321-A

Continuous motion or single-frame recording on 35 mm perforated or unperforated film or recording paper; film speeds variable in steps from 0.8 to 3600 inches/minute. Price $1050.00

DU MONT TECHNICAL PRODUCTS DIVISION
Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

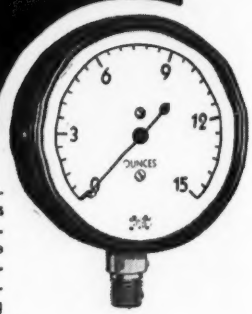
Visit our Booth 339 at the Automation Show, November 26-30, N. Y. C.

For more information circle **91** on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water



Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

MARSHALLTOWN MANUFACTURING CO.

MARSHALLTOWN 3, IOWA

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GOW-MAC CELLS for GAS CHROMATOGRAPHY

. . . FOR HOT OPERATION!

WRITE, WIRE OR TELEPHONE TODAY FOR COMPLETE INFORMATION AND NEW GOW-MAC DATA SHEETS.

- T/C CELLS FOR 225°C OPERATION
- POWER SUPPLY WITH COMPLETE CIRCUITRY FOR 5 MINUTE HOOK-UP
- PANEL UNITS—High sensitivity and high precision panel instrument for gas purity, trace impurities and mixing.

GOW-MAC INSTRUMENT CO.
100 KINGS ROAD, MADISON, N. J.

For more information circle **93** on inquiry card.

EXHIBITORS, PRODUCTS—CONTINUED

L & O RESEARCH AND DEVELOPMENT CORP., Wayne, Pa. 410

Exhibiting: Automatic Frequency Transmission Measuring System (recording frequency transmission of a network from 30 cycles to 150 kilocycles); Flat-copy continuous Scanning Facsimile Transmitter (for regular wire or radio-voice communication-channel transmission of maps, photos, printed or handwritten text, etc.).

LANDIS & GYR, INC., New York 36, N. Y. 533

Exhibiting: Impulse and pre-determined impulse counters; miniature ball and roller bearings.

LARSON INSTRUMENT COMPANY, Terrytown, N. Y. 506

LAROE INSTRUMENT Co., Bethesda 14, Md. 331

G. G. LEEDS CO., Great Neck, L. I., N. Y. 418

Exhibiting: Products of Anatran Engrg. Corp., Electronic Measurements Co., Inc., Houston Technical Labs., Non-Linear Systems, Technical Electronics Corp.

LEETRONICS, INC., Brooklyn 1, N. Y. 550

Exhibiting: New Products—Solenoid-operated ratchet mechanism; rotary stepper. **Regular Products**—Ac rotary solenoid.

In attendance: R. A. Draghi, General Mgr.; H. H. Wolff, Ch. Engr.; J. D. Zasa, Sls. Mgr.

G. H. LELAND, INC., Dayton 2, Ohio 324

Exhibiting: New Products—Ledex rotary solenoids; circuit selectors; stepping switches; and hermetically sealed units.

LIBRASCOPE, INC., Glendale 1, Calif. 325

(see Royal McBee Corp.)

MACKENZIE WALTON CO., Pawtucket, R. I. 162

Exhibiting: Seamless tubing of copper, brass, bronze, nickel silver and other copper-base alloys, in capillary, bourdon spring, thin wall, braid covered and special shape.

In attendance: Norman W. Fulton, V. P. & Gen. Mgr.; J. Louis Schaefer, Asst. to the V. P.; Robert J. Eberts, Jr., Plt. Engr.; Morris Wuerpel, Sls. Mgr.; John J. Condon, David C. Clem, William A. Olson, Sls. Reps.

MAGNETIC ANALYSIS CORPORATION, Long Island City 1, N. Y. 515

Exhibiting: Magnetic analysis equipments; comparator; metal tester.

In attendance: Wm. S. Gould, Jr.; Pres.; J. M. Callan, Ch. Engr.; V. L. Spoley, J. C. DeMaio, Field Engrs.

GORDON L. MATTSON & ASSOCIATES, Chicago 3, Ill. 545

MICRO SWITCH DIV., Minneapolis-Honeywell Reg. Co., Freeport, Ill. 126, 127

Exhibiting: New Products—3-Light Plug-in Pushbutton Switch—3 separate lamps alternately light the plastic button; snap-action operation; connections to lamps and basic switches pre-wired to female connector. **Regular Products**—Precision snap-action switches and mercury switches. Rotary, toggle and pushbutton manual types. Roller arm, leaf, lever, plunger, rod mechanical types.

In attendance: Gerry Boyle, John Tropsa, Bill Greaser, Ken Davies, Bob Remley, Bill Madelung, John Scott, Al Bahnsen, George McNamara, Fld. Engrs.

MIDWESTERN INSTRUMENTS, Tulsa, Okla. 441

Exhibiting: New Products—Model 560 oscillograph for recording under extreme acceleration and shock conditions. **Regular Products**—Oscillographs; magnetic structures; galvanometers; bridge balance units; hydraulic servovalves; torque motors; servoamplifiers; data repeaters.

In attendance: F. B. Cope, Jim Wood, Rex Welch, Sls. Engrs.; K. C. Danney, Steve Wilmot, Fld. Service Engrs.

MINIATURE PRECISION BEARINGS, INC., Keene, N. H. 540

Exhibiting: New Products—Miniature precision ball bearings.

MINNEAPOLIS-HONEYWELL REG. CO., MACHINE CONTROLS DIV., Minneapolis 8, Minn. 124

Exhibiting: New Products—Transistor servo amplifier; Electro-hydraulic servovalves; Electro-hydraulic control systems; Two-axis tracer system for hydraulic or electric drives.

In attendance: John J. Rudolf, Mgr., Machine Controls Div.; Howard L. Harrison, Supv., Machine Controls Div.; Robert L. Fillmore, Sr. Dev. Engr., Machine Controls Div.

MODERNAIR CORP., San Leandro, Calif. 343

Exhibiting: New Products—Heavy Duty Cylinders—Solenoid Valves; Pneumatic cylinders and Control valves in typical circuits as applied to industrial applications. **Regular Products**—Hydraulic cylinders and valves; Pumping Units; Filters, Regulators, Lubricators.

In attendance: John E. Goldring, Pres.; Wm. W. Burke, Joseph P. Strassle, Anthony B. Ulva, Edward Bedell, Arthur J. Whitney, Austin F. Lawther, Sls. Mgrs.

NASH ENGINEERING COMPANY, South Norwalk, Conn. 163, 164

Exhibiting: Air compressors for automation instrumentation.

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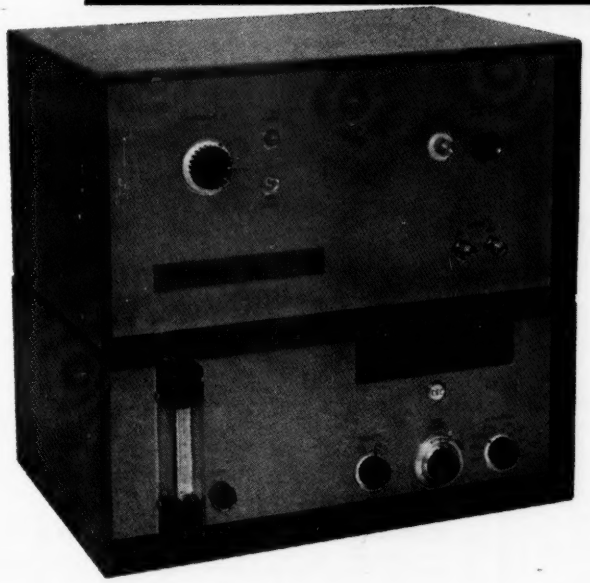

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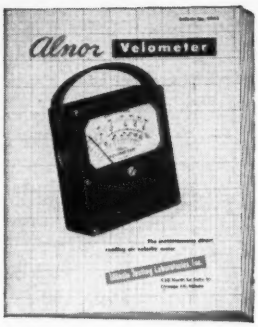

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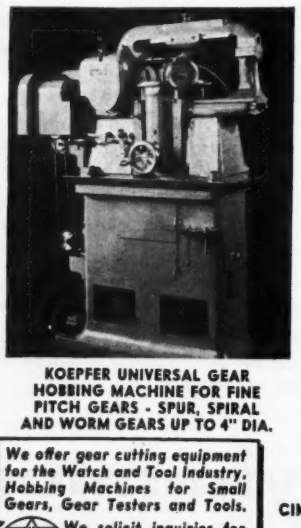

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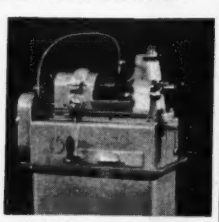

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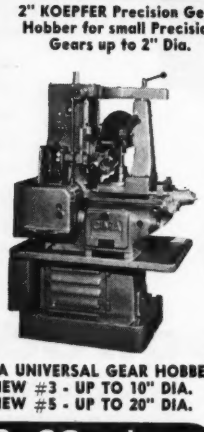

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EXHIBITORS, PRODUCTS—CONTINUED

NATIONAL CASH REGISTER CO., Dayton 9, Ohio 147, 148, 149

Exhibiting: New Products—Model 38-M accounting machine with new approach to combined multiplying and bookkeeping. **Regular Products**—Class 31 accounting machine with full-amount keyboard and built-in electric typewriter.

NORTH AMERICAN AVIATION, INC., ROCKETDYNE DIV., Los Angeles 45, Calif. 412

Exhibiting: New Products—Aircraft guidance equipment; Airborne Digital Computers.

NORTH AMERICAN VAN LINES, INC., Fort Wayne 1, Ind. 445

Services: Movers of high value products (such as electronic devices and instruments of very fragile nature, etc.), exhibit displays, new uncrated furniture, world wide service via land-sea-air.
In attendance: Harold S. Bechert, George H. Smith, J. J. McElwain.

PAK-RAPID, INC., West Conshohocken, Pa. 129

Exhibiting: New Products—Packaging machine equipped with feeding mechanism, automatic printing unit, and attachment which automatically removes air from package and inspects each package for leakers.
In attendance: James Irvine, Pres.; Benjamin Karpowicz, V. P.; Samuel B. Vrooman, Sec.; John J. Coakley, Tech.; E. M. Porter, George Rawak, Sls. Reps.

PANELLIT, INC., Skokie, Ill. 529, 530

Exhibiting: New Products—Automatic Process Information Systems; Centralized Process Control Systems; Industrial Annunciators.

PAR-METAL PRODUCTS CORP., Long Island City 3, N. Y. 344

Exhibiting: New Products—Universal Cabinet Racks with fixed or detachable side panels for standard 19" and 24" wide panels and complete accessories such as vertical side supports, mounting angles, chassis, phono changers, etc. **Regular Products**—Utility Desk Assemblies—in single, double, or triple arrangements; cabinet racks; chassis; panels.
In attendance: A. A. Parmet; John Novak; I. Wertentheil; J. Blatt.

PIC DESIGN DIV., BENRUS WATCH CO., E. Rockaway, L. I., N. Y. 554

Exhibiting: New products such as 120 pitch gears, gear blanks, special bore gears. **Regular Products**—Precision instrument components.
In attendance: Winfred M. Berg, Pres.; P. Wallenberger, Sls. Mgr.; R. Schwemker, V. P.; R. S. Christie, S. Christie, H. Notes, J. Kendall, A. Calhone, T. Swartz, Sls.

GEORGE A. PHILBRICK RESEARCHES, INC., Boston 10, Mass. 142

Exhibiting: New Products—Octal Plug-in Computing Amplifiers; Passive Plug-in Computing Networks; Precision Regulated Power Supplies.
In attendance: John M. Embree, Dir. Sls. and Appl. Eng'ng.—Philbrick Researches; Robert Crane, Mgr.—Kee Enterprises; Bill Brown, Mgr.—Technical Instruments, Inc.; Jack Riley, Bart Healey, Donald Jenkins, Eugene Haas, Haig Tatosian, Eng'ng. Representatives—Technical Instruments, Inc.

P-K INDUSTRIES, INC., North Arlington, N. J. 526

Exhibiting: Paul Venturi Ball Control Valves.

POST MACHINERY CO., ELECTRONIC PRODUCTS DIV., Beverly, Mass. 501

Exhibiting: New Products—Multi-channel Input Control (counts to 12 lines simultaneously using one electronic counter); Edge-Register Detector; magnetic switch for high and low speed rpm counting.
In attendance: Walter P. Fergani, Pres.; Harold L. Carlman, Sls. Mgr.; Joseph L. Forni, Adv. Mgr.; Lawrence A. Tibbetts, Asst. Sls. Mgr.; James W. Farmer, Ch. Electronic Engr.; William Longval, Dev. Engr.; Albert K. Scriven, Ch. Engr.

POTTER & BRUMFIELD MFG. CO., INC., Princeton, Ind. 152

Exhibiting: New Products—Electric Relays.

PRODUCTION INSTRUMENT COMPANY, Chicago 6, Ill. 303

Exhibiting: Electric counters; dozens counters; automatic batch counters, stroke and revolution counters; other counting devices.

POTTER INSTRUMENT CO., Great Neck, L. I., N. Y. 549

Exhibiting: Digital Magnetic Tape Handler; Perforated Tape Reader; Magnistors; Frequency Time Counter; data handling equipment.

THE PYLE-NATIONAL COMPANY, Chicago 51, Ill. 123

Exhibiting: New Products—"W" Series submersible all-weather heavy-duty connectors, plugs, receptacles. **Regular Products**—Electrical connectors, plugs, receptacles; circuit control pylets; signal lights; Pylet conduit fittings.
In attendance: W. Raymond, Mgr. Sls., J. Shearer, Asst. Mgr. Sls., Connector Div.; G. J. Loewe, Dist. Mgr.; H. F. Whalen, Asst. Dist. Mgr.; R. B. Saunders, L. J. Milewicz, Sls. Reps.

REEVES INSTRUMENT CORP., New York 28, N. Y. 333

Exhibiting: New Products—REACR electronic analog computers, automatic control equipment; servo-mechanical parts; resolvers; gyros.

REEVES SOUNDCRAFT CORP., New York 22, N. Y. 341

Exhibiting: New Products—Type A instrumentation tape for data

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The Automatic Factory by Stephen A. June, et al, 1955, cloth, 88 pages. Price $1.50 ☐

Process Control by A. J. Young. 1954, 140 pages, 3-page index. Price $2.00 ☐

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REINHOLD PUBLISHING CORP., New York 22, N. Y. **342**
Exhibiting: "Automatic Control magazine."

REMINGTON RAND DIV., SPERRY RAND CORP., New York 10, N. Y. **534, 537**
Exhibiting: Offices and engineering computer equipment.

REVCO, INC., Minneapolis 5, Minn. **146**
Exhibiting: New Products—Motorized Zero-Max variable speed reducers; infinitely variable "Geneva-Motion" units; Zero-Max with screw control. **Regular Products**—variable speed Zero-Max; variable gearhead units; TORK-O-STAT overload relays.
In attendance: Richard G. Gray, Pres.; Richard G. Hersey, Sls. Engr.; Leo S. Cross, Alex Benzemann, Arch Mason, Alex Gabriels, Frank Tracy, Earl Whitaker, William Cross, Harold Fox, Clair Williamson, Sls. Reps.

ROYAL MCBEE CORP., Port Chester, N. Y. **325**
Exhibiting: Librascope computer equipment, including LGP-30 digital computer.

SANDERS ASSOCIATES, INC., Nashua, N. H. **338**
Exhibitors: New Products—Flexible Printed Circuitry & Cables—cables and harnesses in flat form, single or multi-layer construction, using printed circuits on flexible KelF; Electro-hydraulic Servo Valves, including Model SA-19 for extremely low temperature with low (200-1000 psi) pressure operation. **Regular Products**—Minicube blowers; phase comparators, Tri-Plate microwave attenuators, accelerometers, mylar capacitors.
In attendance: William B. Wilkens, Sls. Mgr.; Kenneth S. Knapton, Jr., Application Engr.; Louis A. Garten, James A. Lynch, Representatives.

SENSITIVE RESEARCH INSTRUMENT CO., Mt. Vernon, N. Y. **521**

THE SERVO SYSTEMS CO., Newark 12, N. J. **414**
Exhibiting: New Products—Servo-Kit a low-cost basic laboratory tool consisting of a vacuum tube amplifier, two Barber-Colman servo motors and the Rider training course, "Basic Synchros and Servomechanisms"; instrument servo amplifiers; indicator servo assembly "Model 6B-1"; automatic positioning control "Model AS". **Regular Products**—Commercial electrical and electronic servo system components.
In attendance: Fred B. MacLaren, Joel P. Wallenstein, Engrs.; Julian F. Reichman, Walter B. Reichman, Salesmen.

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SERVOMECHANISMS, INC., Westbury, N. Y. **525**
Exhibiting: Instrument motors and accessory equipment including, hysteresis synchronous motors, control motors, Damped Control Motors, axial flow blowers, power supplies, etc.
In attendance: Thomas R. Cataldo, Sls. Mgr.; Franklin A. Watson, John A. McMahon, William McCutcheon, Nicholas A. Christian, Sls. Engrs.; Ronald J. Gray, Adv. Co-ord.

SHEPARD LABORATORIES, INC., Summit, N. J. **538**
Exhibiting: New Products—Electronic Film Splicer to weld without cement "Cronar", Mylar, Acetate or Nitrate based 35mm, Cinemascope, 16mm film; flip-flop tube checker. **Regular Products**—Electronic high-speed "Typer" producing "hard copy" from output of electronic computer, card reader, or magnetic tape. Servo transport digital tape reader.
In attendance: Francis H. Shepard, Jr., Pres.; Richard D. Schotter, Chf. Engr.; Walter Hladky, Electronic Engr.; John Slohoda, Electronic Production Engr.; L. Earl Crouse, Sec.; Leroy Coe, Proj. Engr.

SOROBAN ENGINEERING, INC., Melbourne, Fla. **403**
Exhibiting: New Products—Paper Tape Data Preparation Devices and Data Output Tabulating Equipments.

STANDARD ELECTRONICS RESEARCH CORP., New York 21, N. Y. **442**
Exhibiting: New Products—Maser-new molecular oscillator utilizing ammonia to obtain a frequency of 23,870,131,12 . . . KC/sec with a stability of 1 part in 10^{10}. Makes possible the construction of frequency standards of hitherto untold stability. **Regular Products**—Diamacontrol, Diamatrol, Integrator, X-ray Gages.
In attendance: Dr. Frederic Fua, Res. Dir.; M. N. Kirby, Sls. Mgr.; Howard Jackson, Engr.

ALVIN M. STOCK, INC., Union City, N. J. **347**
Exhibiting: Indicating, non-indicating and recording temperature controls for hazardous locations; refrigeration, heating, and cooling, controls; process timers; temperature limit controls; combustion safeguards and igniters; electric valves for gas, air, steam and oil.
In attendance: Alvin M. Stock, Pres.; Arthur J. Kelley, V. P.; Norbert E. Bertl, V. P.; Albert M. Whitman, Harry Garrison, Walter Fodor, Sls. Engrs.; William S. Pope, Office Mgr.

STROMBERG-CARLSON CO., A DIV. OF GENERAL DYNAMICS, Rochester 3, N. Y. **158**
Exhibiting: New Products—XY Data Switching System—to switch electronically, information on Teleprinter circuits. EUCLID Solid State Computer—Electronic printed wiring units for use in data processing. 24-Button Key Switches—features 24 switches on one mounting. "BP" Relay—Gang type relay accommodating 100 "make" combinations or equivalent. Deca Switch—Stepping switch that will step over 11 steps on 4 levels.

SUPERIOR ELECTRIC CO., Bristol, Conn. **119, 120**
Exhibiting: New Products—"Stabiline" automatic voltage regulators Type TM (Tubeless Magnetic). **Regular Products**—"Powerstat" variable transformers; "Stabiline" automatic voltage regulators; "Varicell" d-c power supplies; "Voltbox" a-c power supplies; "Superior" 5-way binding posts.
In attendance: B. G. Deming, District Mgr.; J. S. Louden, Sls. Mgr.; C. Downey, J. Bradley, P. James, Sls. Engrs.

SURPRENANT MFG. CO., Clinton, Mass. **350**
Exhibiting: Regular Products—Engineered wire and cable for the electronic and aircraft industries.
In attendance: G. J. Mulloney, Richard Surprenant, George Gannon, Frank Wynn, Jack Wright, Sls. Engrs.; D. C. Alexander, Ch. Engr.

TECH LABORATORIES, INC., Palisades Park, N. J. **420**
Exhibiting: New Products—High quality long-life stepping switches for automation, remote control, and telemetering. **Regular Products**—Attenuators, potentiometers, switches.
In attendance: Magnus Bjorndal, Pres.; Gerrit J. Van Barren, Sls. Mgr.; Erling Bjorndal, Customer Service; Joseph L. Duffy, Asst. Sls. Mgr.

TELAUTOGRAPH CORP., Los Angeles 19, Calif. **143**
Exhibiting: New Products—Telescribers Systems; "Electronic Longhand."

TELEREGISTER CORP., Stamford, Conn. **436**
Exhibiting: New Products—Electronic Data Processing and Transmission equipment.

THOMAS FLEXIBLE COUPLING CO., Warren, Pa. **145**
Exhibiting: Miniature flexible couplings for use on servos, computers, etc.

TOLEDO SCALE CO., Toledo 1, Ohio **317**
Exhibiting: New Products—Industrial Weighing Equipment.

TRANSITRON, INC., Manchester, N. H. **438**
Exhibiting: New Products—Transitron SG-132 Precision VHF-UHF sweep signal generator operating between 10 and 480 megacycles per second. **Regular Products**—Precision VHF signal generators; spectrum analyzer; laboratory accessories.
In attendance: S. K. Lackoff, Pres.; R. H. Baer, V. P. for Engrg; A. Axelrod, Chf. Electronics Engr.

TRINCOR CORPORATION Representing Hankison Corporation, Trinity Equipment Corp., Industrol Corporation, Uniflow Valve Corporation **165**
Exhibiting: New Products—Industrol Corp.—Purging Systems (completely automatic compressor-dehydrator units for the pressurizing and purging of transmission lines. Uniflow Valve Corp.—Control valves. **Regular Products**—Hankison Corp.—Condensifilters, Dehydrafilters;

Industrol Corp.—Midget Dryers; Trinity Equipment Corp.—Thermowells; multipoint thermocouple assemblies.

UNDERWOOD CORPORATION, New York 16, N. Y. **429**

Exhibiting: New Products—Electric Servotyper.

UNIVERSAL GENERAL CORP., NEW York 13, N. Y. **121**

Exhibiting: New Products—"Super-Modern" automatic dial telephone system. Regular Products—Relays; solenoids; Sensitrols; stepping switches; shock mounts.

In attendance: Morris Greenberg, Pres.; Robert G. Herzog, V. P.; Frances Pollock, Asst. Secy.; H. B. Smith, Mgr. Telephone Div.; Joseph DeJusto, Chg. of Special Tests, etc.; Phillip M. Ryan, Consultant on Computers.

VEEDER-ROOT, INC., Hartford 2, Conn. **323**

Exhibiting: A-c and d-c electrically operated counting devices.

WARNER & SWASEY RESEARCH CORP., New York 1, N. Y. **443**

Exhibiting: New Products—"Probomat Automatic Control Units" for precision positioning of machine tools, with tape, card and Pre-Set programming. The Probomat Controls are applicable to jig borers, milling and boring machines, rotary and rectangular positioning tables.

Regular Products—"Probograph automatic recording precision measuring machines; "Probomat" tape or card programmed automatic precision measuring machines.

In attendance: W. S. Tandler, Pres.; Charles R. Eltinge, Sls. Mgr.; George Schaffer, Asst. to Pres.; Arthur Sloan, Appl. Engr.

WECKESSER COMPANY, Chicago 30, Ill. **128**

Exhibiting: New Products—Threaded nylon rod; molded nylon screws; nylon washers. Regular Products—Nylon and plastic cable clamps, metal re-enforcing washers for same; perforated nylon strapping; molded nylon screws and nuts; stampings.

In attendance: Harry A. Ewalt, Gen. Mgr.

WOLLENSAK OPTICAL CO., Rochester 21, N. Y. **518**

Exhibiting: New Products—Fastax Division's line of high-speed photographic instrumentation equipment.

ZENITH ELECTRIC CO., Chicago 10, Ill. **103**

Exhibiting: New Products—Automatic control equipment; timers; switches.

ZOOMAR, INC., Glen Cove, N. Y. **320**

Exhibiting: New Products—Remote controlled and manual controlled Zoomar lenses demonstrated live on television cameras of different makes.

In attendance: Walter Steuer, V. P.-Sls. Mgr.; Herbert Lowen, Ch. Mathematician; Alfred J. Quittner, Ch. Engr.

Employment Center

AMERICAN BOSCH ARMA CORP., Garden City, L. I., N. Y. **614, 616**

AMERICAN SUGAR REFINING CO., IND. RELATIONS DIV., New York 5, N. Y. **602**

EMERSON RADIO & TV., Jersey City, N. J. **628**

GENERAL ELECTRIC CO., INDUSTRIAL COMPUTER SECTION, Syracuse, N. Y. **629**

GENERAL ELECTRIC CO., SMALL AIRCRAFT ENGINE DIV. West Lynn, Mass. **647**

HOOVER ELECTRONICS **627**

INTERNATIONAL BUSINESS MACHINES CORP., New York, N. Y. **611, 605**

KOLLSMAN INSTRUMENT CORP., Long Island, N. Y. **649**

LOCKHEED AIRCRAFT CO., Atlanta, Ga. **626**

GLENN L. MARTIN, Baltimore, Md. **646**

MINNEAPOLIS-HONEYWELL REGULATOR CO., Minneapolis, Minn. **603, 604**

NORTH AMERICAN AVIATION, INC., COLUMBUS DIV., Downey, Calif. **601**

NORTH AMERICAN AVIATION, Downey, Calif. **620, 622**

PILLSBURY MILLS, INC., Minneapolis 2, Minn. **631**

REMINGTON RAND UNIVAC, New York, N. Y. **652**

SPERRY GYROSCOPE CO., Great Neck, L. I., N. Y. **651**

STAVID ENGINEERING **606**

TELEREGISTER, Stamford, Conn. **648**

WESTINGHOUSE ATOMIC, Bettis Field Pgh., Pa. **612, 615**

Now... a fully-Armoured FLOW INDICATOR simple as...

1 There's not a single stuffing box, yet this Model 3602 Armoured Flow Indicator handles pressures to 3000 psig; temperatures to 500° F. Eight ranges cover flows from 1.5 to 1200 GPH water. It's all metal with a positive-bond magnetic indicating follower ... and only 7 inches high.

2 Disassembly is the simplest ever ... without removal from the line. Head is rotatable.

3 Cleaning is a snap ... so are range changes. Metering plug and interchangeable orifice simply lift out. Plug seat automatically checks back flow.

Send for Bulletin 360

BROOKS ROTAMETER COMPANY

104 EIGHTH STREET • LANSDALE, PA.

For more information circle **100** on inquiry card.

HELLER COP ELECTRONIC COMPONENTS

Self-adjusting DC motor speeds from AC lines!

HELLER ELECTRONIC

Control Of Power

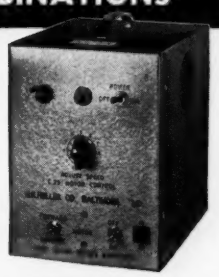
MATCHED COMBINATIONS

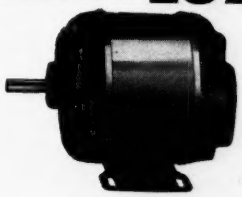
C-25 ELECTRONIC TUBE OPERATED CONTROLLER

with matching

¼ H.P. DC MOTOR

Complete, F.O.B. Baltimore, Md. $187





Other plain and gear motors available

SPECIFICATIONS

- Input: 110-120 V., 60 cy. single phase
- Output: 0-120 V., 2.5 amps DC to armature
- Field constant voltage 110 V. DC
- Full ¼ h.p., ball bearing, Master shunt wound DC motor. 200-2000 R.P.M.
- Dynamic Brake ● Reversible ● Full torque

GERALD K. HELLER CO.

1 N. Carey St., Baltimore 23, Md., U. S. A.

For more information circle **101** on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

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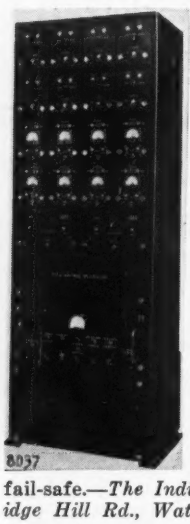
PROCESS MEASUREMENT and CONTROL

PROCESS INSTRUMENTATION

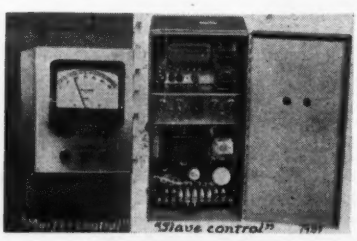

8037

New "packaged" protective and measuring system for oil and gas pipelines and chemical industry comprise individual plug-in electronic units for temperature, pressure, and vibration-alarm and shut-down functions; pressure measurement; and telemetering. Primary elements: resistance bulbs, pressure and vibration pickups, etc. Systems are explosion-proof and fail-safe.—*The Indikon Co., 76 Coolidge Hill Rd., Watertown 72, Mass.*

For more information circle **301** on inquiry card.

SUPERVISORY AND REMOTE POSITIONING CONTROL SYSTEM

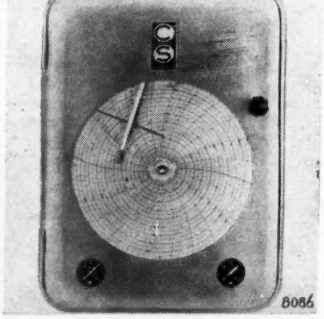
New variable remote control system enables both positioning and proportioning plus monitoring of remote equipment over one circuit. By moving a panel key a supervisor can, for instance, actuate a remote operator in "increase" or "decrease" direction and simultaneously observe resultant change in affected flow, pressure, etc. System features modular construction; can be installed by average plant electrician. As requirements grow, modules can be added. Visible and audible alarm, as well as fail-safe lockout and hold-out features, can be added.—*The Sparks-Withington Co., Sparton Control Systems Div., Jackson, Mich.*


"Slave control"

For more information circle **302** on inquiry card.

PRESSURE AND TEMPERATURE INSTRUMENTATION

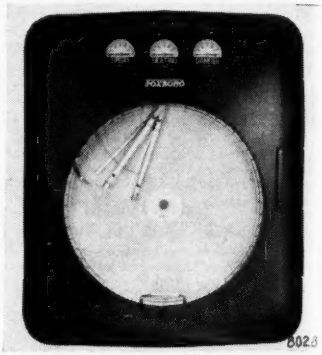
New pressure and temperature recording controllers and recorders are added to maker's line. "Type 57" pneumatic recording controller (illustrated) controls and records both pressure and temperature. Available models have 9" or 12" spring- or electric-driven charts; on-off or 1-100% proportional action. Pressure ranges 0-5 to 0-5000 psi (0-25,000 psi for 12" single pen only); temperature range −350°F to 1200°F. "Type 58" recorder records pressure and temperature, in same ranges as "Type 57." 6", 9", or 12" charts, spring- or electric-driven; one to four pens. Accuracy 1%.—*A. W. Cash Co., P. O. Box 551, Decatur, Ill.*


8086

For more information circle **303** on inquiry card.

DRY KILN CONTROLLERS

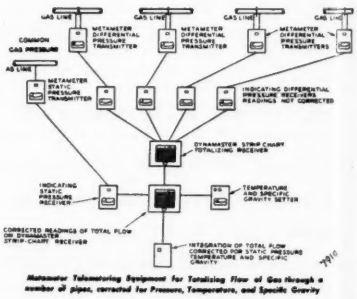
New series of instruments, designed specifically for lumber drying operations, supersedes circular case models; embodies latest developments in controller design; includes both Single-Zone and Multi-Zone Temperature-Humidity Recorder-Controllers. On-off wet and dry bulb control standard; narrow band proportional control optional (particularly useful in reducing damper "whipping").—*Foxboro Co., Foxboro, Mass.*


8028

For more information circle **304** on inquiry card.

COMPENSATED-TOTALIZING TELEMETERING SYSTEM

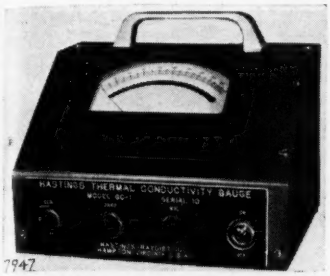
New system of telemetering transmitters and receivers and electronic self-balancing instruments totalizes several flow measurements, corrects for temperature, pressure, specific gravity and supercompressibility to provide a corrected flow value. Instruments can be supplied also in various types to perform averaging, totalizing, multiplying, and dividing computations involving basic measured variables listed above; also to extract square root, square, or otherwise compensate mathematically.—*—The Bristol Company, Waterbury 20, Conn.*


Metameter Telemetering Equipment for Totalizing Flow of Gas through a number of pipes, corrected for Pressure, Temperature, and Specific Gravity

For more information circle **305** on inquiry card.

THERMAL CONDUCTIVITY GAGE

New type of gas thermal conductivity measuring instrument utilizes maker's compensated thermopile



principle said to end "instability and temperature effects of the older resistance type instruments." New cell incorporates six noble-metal thermocouples, arranged to compensate for temperature changes in gas sample and also for rate of change of temperature effects.—*Hastings-Raydist, Inc., Hampton, Va.*

For more information circle **306** on inquiry card.

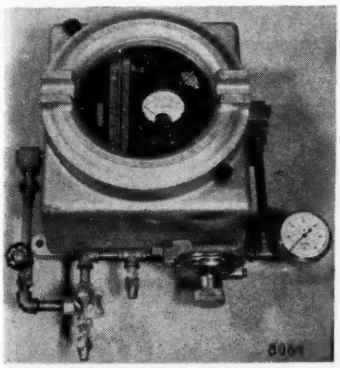
ELECTRICAL CONDUCTIVITY CELL

New corrosion-proof variable-immersion conductivity cell features a type 301 stainless steel body, Teflon cell parts, graphite electrodes, and an extremely high cell constant; is for use in moderately strong HNO_3 containing chlorides.—*Industrial Instruments, Inc., Cedar Grove, N. J.*

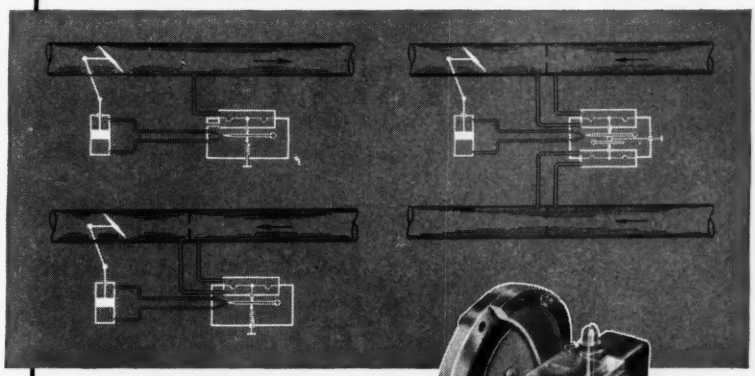
For more information circle **307** on inquiry card.

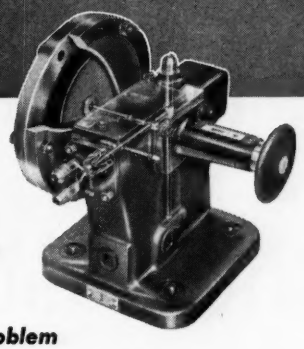
THERMAL CONDUCTIVITY-TYPE SELECTIVE ANALYZER

New "Thermatron" permits measuring concentration of one gas in mixtures of gases more specifically than heretofore, and without sample-condi-



THE "Jet-Pipe" AGE IS HERE...
FOR PRESSURE, FLOW, COMBUSTION OR RATIO CONTROL





and so is the

ASKANIA
Jet-Pipe Regulator

...the simplest accurate long-life solution to any regulator problem

• Check your most desirable specifications for the IDEAL regulator to control pressure—flow—combustion—proportion—other variables.

Do they include

1 Rugged Construction **2** Dependability **3** Long Life **4** Accuracy **5** Speed **6** Inexpensive Maintenance **7** Unimpeded Operation in Freezing Weather **8** Freedom for use ANYWHERE?

All these features are common to all ASKANIA Jet-Pipe Regulators.

From Minute Signal to POWERFUL FORCE

The real magic behind the Jet-Pipe Regulator is the power which can be initiated by a minute signal—the degree to which the signal can be amplified—and the speed and accuracy with which it can be transmitted. The conversion of kinetic energy (velocity pressure) into potential energy (static pressure) is an important factor which multiplies the dependability you can expect in every ASKANIA control. The heart of ASKANIA Regulators—the Jet-Pipe—is practically frictionless. Bearings are continuously immersed in oil. Condensation and freezing are impossible. In every way, ASKANIA Regulators are designed and built for continuous, trouble free service over the years.

Applicable to these Controlled Variables:

PRESSURE (Gage, Absolute & Differential) • DRAFT • COMBUSTION • FLOW LEVEL • DEPTH • RATIO • SPEED • DENSITY • CONSISTENCY • EDGE POSITION AND OTHERS

What is your problem? For further information on the type of regulator control which best fits your operation, send today for Bulletin No. 139 and 155. Write the ASKANIA REGULATOR COMPANY, *268 East Ontario St., Chicago, Illinois.*

ASKANIA REGULATOR COMPANY

"CONTROLS FOR INDUSTRY"

HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A Subsidiary of General Precision Equipment Corporation

For more information circle **102** on inquiry card.

CORROSION

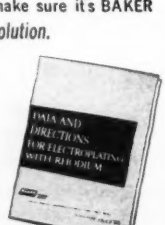
WITH

RHODIUM PLATING

—and be sure it's a BAKER SOLUTION!

Yes . . . the problem of better electrical contact performance is easily solved . . . *with Rhodium-plated contacts. Rhodium* protects permanently against corrosion . . . *provides hard, oxide-free contact* surface . . . low, stable contact resistance . . . *permits higher pressures, provides* low noise level in moving contacts . . . *and it wears longer! For uniformly* ideal results . . . make sure it's BAKER *Rhodium Plating Solution.*

Write for free booklet on Rhodium Plating and its advantages.



BAKER & COMPANY INC ***PRECIOUS METALS***

113 ASTOR STREET, NEWARK 5, N. J.
NEW YORK • CHICAGO
SAN FRANCISCO • LOS ANGELES

ENGELHARD INDUSTRIES

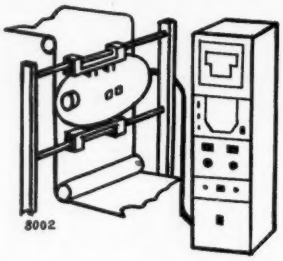
For more information circle **103** on inquiry card.

tioning procedures. Measurements are based on thermal-conductivity principle but also take advantage of convective heat loss. This is done by using four detector cells instead of usual two: Two additional cells are large-diameter, to promote convective heat loss. Filaments of four cells are arranged to maximize effects of the gas to be measured.—*Mine Safety Appliances Co., Pittsburgh 8, Penna.*

For more information circle **308** on inquiry card.

COATING-THICKNESS GAGE AND STREAM ANALYZER

New x-ray fluorescence instrument permits continuous determination of metal-coating thickness to microinch



precision; serves also for continuous analytical control in industries where a single element determination is of importance. Three primary components: (1) x-ray head comprising x-ray tube and two detector heads, (2) high-voltage source and (3) ratio recorder comprising an L&N strip-chart recorder, ratio amplifier, and high-voltage Geiger supply. Ratio recorder reads direct ratios of current signals from the Geigers of the two detector heads, one measuring for the element to be determined, and the other a standard reference signal.—*Applied Research Lab., P. O. Box* 1710, *Glendale* 5, *Calif.*

For more information circle **309** on inquiry card.

PHOTOELECTRIC CONTROL SYSTEM

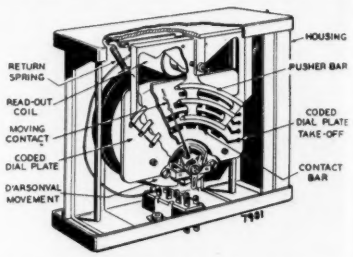
New "PE-150" is inexpensive control that "can be set up by anyone . . . simply plug in like a lamp."

Properly placed controls can separate objects according to height. Reflected light can be used to identify light and dark objects. Contacts control 10 amp at 110 vac.—*Ripley Company Inc., Middletown, Conn.*

For more information circle **310** on inquiry card.

POINTER-DEFLECTION CODER

New "LIAD Multi-contact Meter Relay" has a conventional permanent-magnet moving-coil movement but,

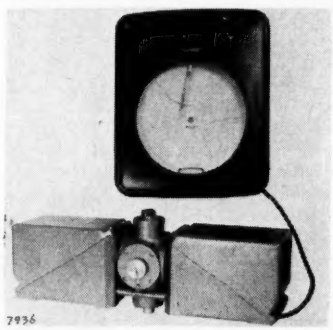


instead of a dial, one to six segmented bands whereby pointer deflection is converted into binary information.—*Assembly Products Inc., Chesterland* 3, *Ohio.*

For more information circle **311** on inquiry card.

TURBIDITY RECORDER

New "Turbidity Detector-Recorder" makes it possible for the first time to measure beer turbidity continuously

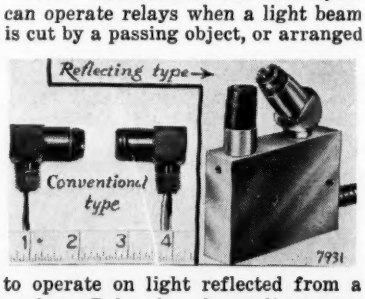


without laboratory analysis; can be equipped with an alarm to signal presence of beer haze.—*The Foxboro Company, Foxboro, Mass.*

For more information circle **312** on inquiry card.

MINIATURE PHOTOELECTRIC CONTROL SYSTEMS

New "Miniaturized Electric Eyes" can operate relays when a light beam is cut by a passing object, or arranged



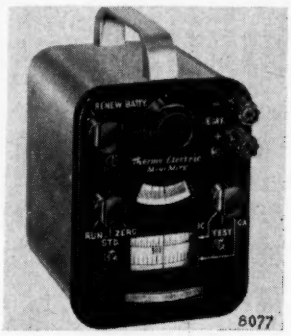
to operate on light reflected from a surface. Relay box has adjustments whereby relay can be set to operate at any desired threshold. Reflecting type can be targeted to operate on a fine line or color difference. Both lead sulfide and cadmium sulfide photocells are available; also circuits involving delays, monitoring, etc.—*Ess Instrument Co., Bergenfield, N. J.*

For more information circle **313** on inquiry card.

TEMPERATURE

PORTABLE POTENTIOMETER

New "MiniMite" weighs under 4 lb and measures about 4" x 5" x 6", yet has a scale 23½" long. Standard



8077

double-scale range 0-1800°F for iron-Constantan and 0-2400°F for Chromel-Alumel. (Others available.) Accuracy 0.25% of scale range. Can be used to check millivoltmeters and potentiometers.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **314** on inquiry card.

PORTABLE PYROMETER

New "Pyrotest 9B" for checking and calibrating all types of plant and lab temperature instruments is said

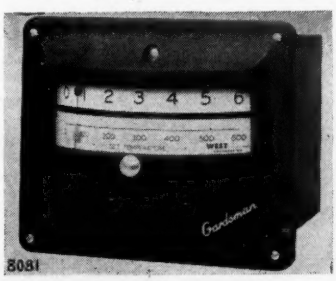
8074

to be "the only instrument of its kind with interchangeable direct-reading scales, and the only single temperature testing unit for use with as many as six types of thermocouples."—*Technique Associates, Inc.*, 211 *E. South St., Indianapolis* 25, *Ind.*

For more information circle **315** on inquiry card.

TEMPERATURE CONTROLLERS

New 3-position pyrometer-type controllers are easily wired for a wide variety of specialized control applica-



8081

GET **3** DIGITAL INSTRUMENTS IN **1**

and eliminate readout error

THE HYCON
RACK MOUNTED AC-DC
VOLT-OHMMETER

MODEL 615R
Digits are ½" high . . .

Decimal point and polarity sign are illuminated.

Readings are repeatable within 1 digit with no parallax or interpolation errors.

Time-proven electromechanical system

Ideal for a broad range of applications, including production-line testing, field service testing, high-precision research and development work, incoming parts inspection and quality control.

The Hycon 615R applies extremely low current through unknown resistance (2.7 ma. max. on XI range . . . 0.00027 ma. max. on X1000 range). Only 5¼" high, the unit fits any standard 19" relay rack.

PLUS THESE OTHER IMPORTANT FEATURES

- Complete overload protection
- Automatic "off-scale" indication
- Jack to permit reading retention
- Special designed counter, life-tested for years of use
- Available in same unit size with complete print-out facilities for permanent records

For further information, write for Bulletin IA-10

SPECIFICATIONS

RANGES—DC: 0-1, 10, 100, 1000 volts
AC: 0-10, 100, 1000 volts
Resistance: 0-1k, 10k, 100k, 1 meg, 10 meg

DC INPUT RESISTANCE—11 megohms

AC FREQUENCY RESPONSE—Direct Probe: 30 cps—3 mc
Crystal Probe: 50 kc—250 mc

INDICATOR—3-digit counter with illuminated decimals and polarity sign

ACCURACY—DC and Resistance: 1% full-scale (0.1% optional)
AC: 2% full-scale

POWER REQUIREMENTS—115 volts, 60 cycles, 50 watts

DIMENSIONS—Standard 19" rack panel 5¼" high; chassis 14" deep

FINISH—Navy Gray 15080-111-2 Panel (or customer preference)

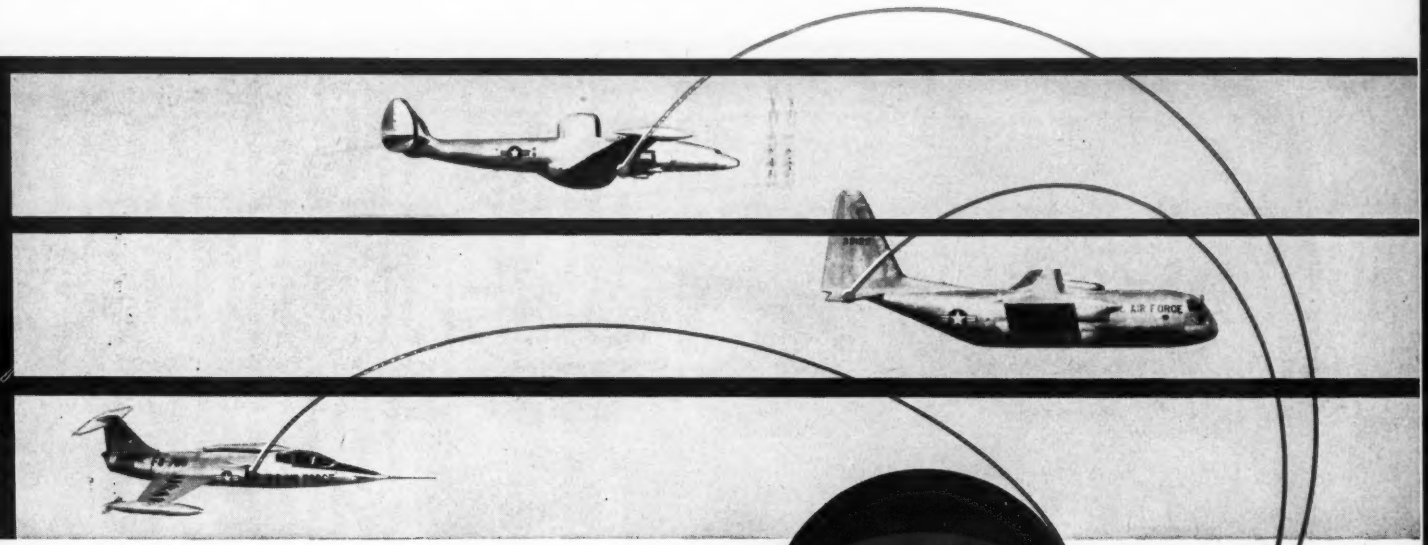
Hycon
ELECTRONICS, INC.

1030 South Arroyo Parkway
P. O. Bin "D"
Pasadena, California

A subsidiary of
HYCON MFG. COMPANY

For more information circle **104** on inquiry card.

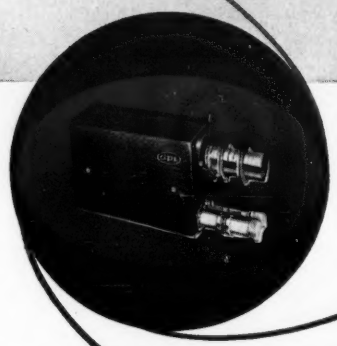
ENGINEERS—working at GPL can put you at the forefront of your profession. Send your resume to Personnel Manager.



ON ENGINE FIRE WALL
GPL Ruggedized TV Camera, mounted to wheel wall housing without shock insulation, monitors landing gear perfectly during take-off, flight, landing.

BENEATH TAIL STABILIZER
Mounted camera enables pilot to observe waver of air flow tufts on horizontal stabilizers as plane approaches stall.

IN JET PLENUM CHAMBER
Camera, dolly-mounted and wheeled through curved air ducts into otherwise inaccessible chamber, checks for presence of foreign objects.



the TV camera that can take it
it's RUGGEDIZED

Unique in closed-circuit TV, this ruggedized, remote-control camera manufactured by GPL packs into six pounds the super-rugged construction that enables it to operate efficiently in extreme environments. It is the only camera to have performed successfully under flight conditions with forces exceeding 15 G's in each of its three axes. Noise levels as high as 175 decibels and altitudes over 70,000 feet do not affect picture detail. Camera can withstand temperatures of minus 55°C to plus 60°C, humidity levels of 100%, and extremely high wind velocities. Though not hermetically sealed, it is spray-proof . . . operating for 800 hours in an icing tunnel, the camera showed no sign of damage or operating failure.

Including motors for remote control of iris and focus, the camera is only 7" long without the lens, 5⅜" high, 3⅛" thick—small enough to fit in almost anywhere. It operates on a 525-line system, 60 fields interlaced, 550-line resolution. No external shock mount is required. All controls can be handled from a remote location. Power requirements are minimum.

This new TV camera results from special aviation test needs of Lockheed Aircraft Corporation. Because of its standing in the TV field, General Precision Laboratory was chosen by Lockheed to produce the small-size, remote-focus camera it had developed. In it, ruggedized components are combined in a unique design that isolates critical vidicon tube and video circuit areas from external vibration. GPL has production-engineered it for widest application in heavy construction, engineering research, automotive testing and many other industrial and military operations, as well as in aviation. Write for further information.

GPL

General Precision Laboratory Incorporated
Pleasantville, New York

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Visit us at Booth 108-9 Automation Exposition

For more information circle 105 on inquiry card.

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General Precision Laboratory Incorporated
Pleasantville, New York
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For more information circle 105 on inquiry card.

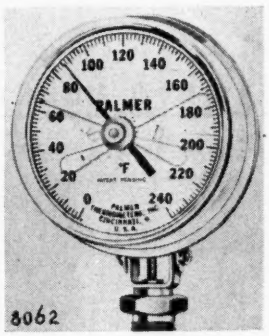
NEW INSTRUMENTS

tions. Two types of neutral band, each with two types of control: One, with a single setting pointer, permits no more than 1% of scale range as neutral; the other, with two settings, permits spread up to 20% of range. On-off or proportioning type control available; also automatic reset. All models are free from vacuum tubes.—*West Instrument Corp., 525 N. Noble St., Chicago, Ill.*

For more information circle **316** on inquiry card.

MAX AND MIN POINTERS FOR DIAL THERMOMETERS

New feature for maker's 3½" and 4½" dial thermometers: red pointer

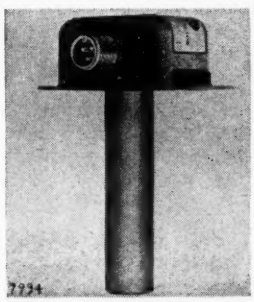


showing maximum and green pointer showing minimum readings; easy to read and to reset.—*Palmer Thermometers, Inc., Cincinnati 12, Ohio.*

For more information circle **317** on inquiry card.

COOLING-EFFECT DETECTOR

New "Series 18801 Thermoswitch," designed to detect inadequate cooling of air-cooled electronic components,



senses combined cooling effect of both ambient temperature and air flow-rate. Since it has its own source of heat, it can be set to simulate conditions in the equipment it protects. It can actuate an alarm or command a cooling device.—*Fenwal Incorporated, Ashland, Mass.*

For more information circle **318** on inquiry card.

MINIATURE BAYONET TCs

New miniature bayonet thermocouples include a wide variety of immersion lengths, adapters, lead wires and terminals; feature rapid response; have spring-loaded hot junc-

NEW KEARFOTT COMPONENTS

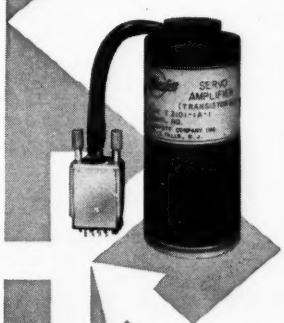
FOR LIGHT, MORE RELIABLE SERVO SYSTEMS

SERVO MOTORS

Standard Kearfott servo motors and servo motor-generator combinations are now available for operation with transistorized amplifiers. These units feature center tapped control phase windings rated 40 volts in series and 20 volts in parallel. Fixed phase excitation to size 10 units is 26 volts 400 cps and to size 11, 15 and 18 motors 115 volts 400 cps.

SUMMARY OF CHARACTERISTICS

Size	Stall Torque	No Load Speed	Watts Phase	Weight
10	.28 oz. in.	6500 RPM	3.1	1.5 oz.
11	.63 oz. in.	6700 RPM	3.5	4.5 oz.
15	1.53 oz. in.	5300 PRM	6	7.30 oz.
18	2.4 oz. in.	5300 RPM	9	12.2 oz.



AMPLIFIERS

A new transistorized servo amplifier suitable for driving size 10 and 11 servo motors is also available. This amplifier provides a 40 volt, 3 watt output. Designed to meet the requirements of MIL-E-5400 it is rated for operation over the ambient temperature range of −54°C to +71°C. A servo type base and a cable with an SM11-20H connector is provided. Dimensions 1 42/64" dia. x 3 25/32" high, weight 8 ozs.

Write Today For Descriptive Technical Data

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

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For more information circle **106** on inquiry card.

for digital computers, inventory control systems and tape-to-card converters, also as delay lines, synchronizers and frequency generators.

- Designed to purchaser's requirements
- Guaranteed accuracy of drum runout .00010" T.I.R. or less
- Air bearings or super-precision ball bearings
- Belt drive or integral motor drive, speeds to 100,000 RPM
- Capacities to 5,000,000 or more binary digits
- Vertical or horizontal housing
- Head mounting surfaces to suit
- High density magnetic oxide or electroplated magnetic alloy coating

High Speed Motors, Spindles and Drums

Bryant designs and manufactures electromechanical components for precision operation up to 200,000 RPM, and magnetic drums from 2" diameter x 3" length to 20" diameter x 42" length. If you have a problem in applying high speed rotating equipment to your product, write Bryant today.

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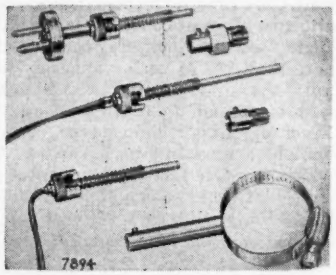
P. O. Box 620-I, Springfield, Vermont, U.S.A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

For more information circle **107** on inquiry card.

NEW INSTRUMENTS



tions. Available: copper-Constantan, iron-Constantan and Chromel-Alumel, three temperature ranges between —300°F and 1400°F.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **319** on inquiry card.

LIQUID LEVEL

LEVEL CONTROLLER

New "Flexotrol" displacement-type liquid level controller has no bearings or knife edges: a torque table replaces pivoting members. Face of torque table, engaging and driving torque tube, is free to twist under action of displacer. Thus, normal process residues do not hamper operation. Available with external displacer chambers or in models for direct displacer immersion in process vessel. Option: direct mechanical liquid level indication. Proportional (1-150%) or two-position action; automatic reset extra. —*Kieley & Mueller, Inc., 64 Genung St., Middletown, N. Y.*

For more information circle **320** on inquiry card.

LIQUID-LEVEL GAGES

New "Red Flasher Truscale" remote-reading liquid level gages have unique new safety features in which

scale face lights up and flashes red continuously to warn when liquid level is too high or too low. Accuracy is 0.5%. They can be equipped with signal horns, lights and up to six repeaters.—*Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.*

For more information circle **321** on inquiry card.

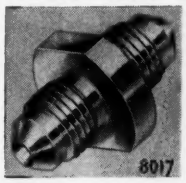
FLOW-RATE

ELECTROMAGNETIC FLOWMETER

New "Nucor Magnaflow" converts liquid velocity into an electric potential without inherent pressure drop; has instantaneous and full-linear response said to make it "ideal for control applications." Dynamic range is limited only by hydraulic system and limits of operating pressures. Instrument can measure flow-rates between 100 cc/min and 2000 gpm. Measurement signal is usually independent of electrical conductivity of liquid; and accuracy of measurement is determined solely by proper design of input circuits of electronic amplifier. Measuring element is a smooth-bore Teflon tube with platinum electrodes.—*Nuclear Corp. of America, Inc., Empire State Bldg., New York 1, N. Y.*

For more information circle **322** on inquiry card.

GAS FLOW RESTRICTORS



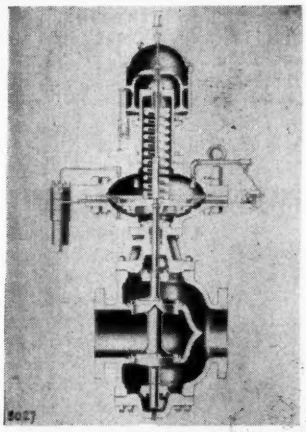
New restrictors, said to represent "a new first in the pneumatic field," restrict gas flow to a predetermined flow rate. By fusing Monel, stainless, and other type metal powders "into a molecular structure," into a fitting similar to an AN fitting, a sintered orifice is obtained, adaptable to all present pneumatic systems where small-hole orifices are now used. Calibrated flow accuracy of 5% is obtainable in production quantities as well as research requirements.—*Del Mfg. Co., 1005 S. Central Ave., Los Angeles 21, Calif*

For more information circle **323** on inquiry card.

PRESSURE and VACUUM

HIGH-PRESSURE REGULATORS

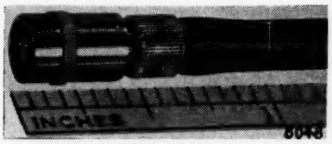
New "Series 883 and 885" are said to solve problem of vertical instability or "jumping" sometimes encountered on high-pressure gas transmission lines. Oil dash-pot damps out any tendency of valve to jump, yet will not cause deviation from control point. Reduced pressure range 100 to 450 psi. Sizes 2" to 12".—*Fisher Governor Co., Marshalltown, Iowa.*



For more information circle **324** on inquiry card.

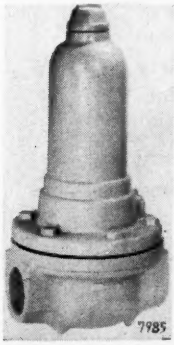
MINIATURE PRESSURE PICKUPS

New "High-precision SLM Pressure Transducers," ¼"D×½"L, feature fast response time (about one microsecond). Signals are free from electrical and mechanical noise. New pickups will also measure steady and slowly varying pressures as well as fast pressure transients; are calibrated by static methods. Four models cover ranges from 0.01 to 100,000 psi.—*Kistler Instrument Co., 15 Webster St., N. Tonawanda, N. Y.*



For more information circle **325** on inquiry card.

GAS PRESSURE REGULATOR

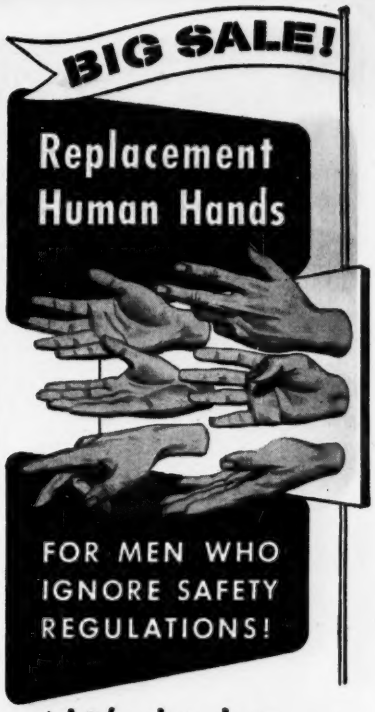


New "141" regulator will withstand momentary overloads as high as 1000 psi on the outlet side; provides extra safety for rural gas services. Versatility: four interchangeable orifices and five interchangeable springs for pressures from 3 psi to 400 psi. Absolute lock-up at zero flow.—*Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.*

For more information circle **326** on inquiry card.

VACUUM GAGE

New "PHG-27" single-station discharge-type vacuum gage measures total pressure of condensable vapors



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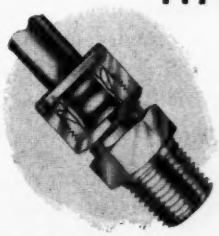

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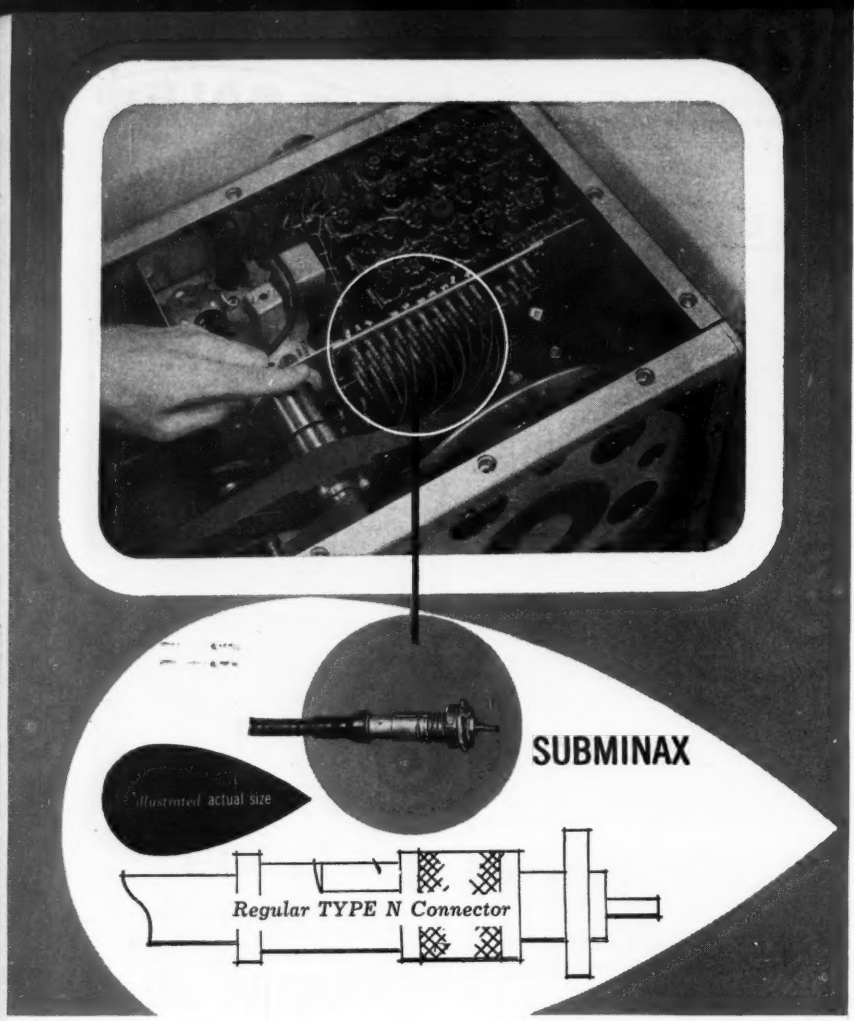
For more information circle **108** on inquiry card.



how SUB*Minax*® RF CONNECTORS SAVE SPACE & WEIGHT for VICTOR

This 30 Channel 400 cycle Airborne Tape Recorder built by Victor Adding Machine Company is a successful example of miniaturization. The design called for one section of thirty-seven 50 ohm RF receptacles and thirty plug/cable assemblies. Victor achieved a *space reduction* of *75%* and a *weight reduction* of *83%* by using AMPHENOL Subminax RF cable and connectors instead of comparable standard-size Series N connectors and matching cable!

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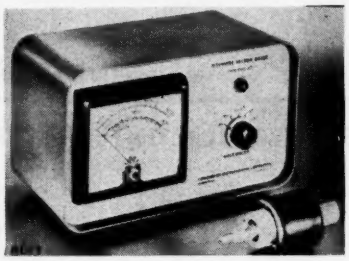
NEW INSTRUMENTS



and permanent gases on three scales: 25 microns to 10^{-4} mm Hg; 10^{-4} to 10^{-5} mm Hg; and 10^{-5} to 10^{-7} mm Hg. New sensing tube does less self-pumping at its highest pressure range than did previous models, thus gives truer pressure readings.—*Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

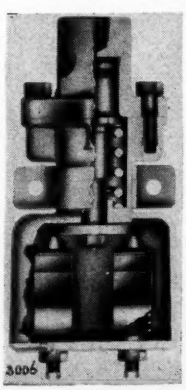
For more information circle **327** on inquiry card.

WATER PRESSURE GAGE

New water pressure test gage is said to be indispensable for every plumber, steamfitter, home engineer, appliance salesmen and air-conditioner engineer; has a 2-1/2" dial with non-breakable crystal; fits any standard water faucet, Range 1 to 200 psi (300- and 400-psi gages can be supplied).—*Marshalltown Mfg. Co., Marshalltown, Iowa.*

For more information circle **328** on inquiry card.

HIGH-LOW PRESSURE SWITCH



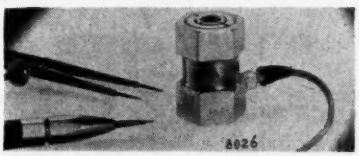
New "9622 or C9622" measures two different pressures in one system and commands independent electric circuits at any two desired points; is useful where system pressure must not exceed or fall below predetermined values. Adjustable range of 15 to 3000 psi (proof pressures from 3000 to 7000 psi). Piston type measuring element can be expected to perform millions of cycles; is not sensitive to jarring or vibration. Two calibrated dials enable user to set either switch. Setting screws can be locked.—*Barksdale Valves, Pressure Switch Div., 5125 Alcoa Ave., Los Angeles 58, Calif.*

For more information circle **329** on inquiry card.

FORCE, LOAD, WEIGHT, DISPLACEMENT

DYNAMIC FORCE GAGES

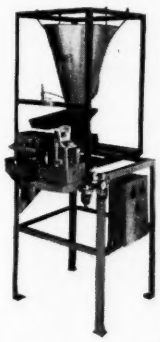
New "Models 2103 and 2104" are said to make possible new methods of dynamic testing; provide voltage out-



put proportional to dynamic force: self-generated outputs of about 5 v full-scale; ranges 100, 500, 1000, and 5000 lbs; unloaded natural frequencies 20 kc to 50 kc; flat frequency response to at least 5 kc. Physical design permits making gage part of support structure or coupling linkage. Electroceramic element (a new development) assures linearity at temperatures from −65°F to 230°F.—*Endevco Corp.*, 161 *East California St., Pasadena, Calif.*

For more information circle **330** on inquiry card.

AUTOMATIC NET WEIGHER

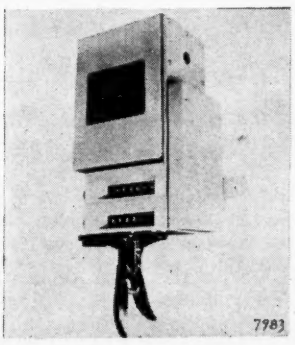


New "Model 620 NW-FM 21-30" automatic net weighing machine, for batching or packaging, incorporates maker's even-balance 1-to-1 ratio precision industrial scale with visual indicator; smooth operating net weigh hopper and automatic cutoff controls with efficient material handling equipment. Over-under indicator for visual checking obviates need for separate checkweighing operation.—*Exact Weight Scale Co.*, 944 *W. 5th Ave., Columbus, Ohio.*

For more information circle **331** on inquiry card.

COUNTER FOR WEIGHERS

New remote electric counter with positive clutch drive can record up to 200 weighings per minute; permits user to tabulate and record a weighing process from any point in his plant; can be used to keep production records, as well as tabulate customers' orders.—*Richardson Scale Co., Van Houten Ave., Clifton, N. J.*



For more information circle **332** on inquiry card.

WELDABLE STRAIN GAGE

New high-temperature strain gage has a dynamic test range to 1600°F; can be spot-welded and test-ready on

flat or curved surfaces in less than five minutes. Spot welding installation seldom causes and significant alteration of structure being tested. Available units have a nominal resistance of 120 ohms and a gage factor of 1.80.—*Micro-Test, Inc.*, 657 *North Spaulding Ave, Los Angeles 36, Calif.*

For more information circle **333** on inquiry card.

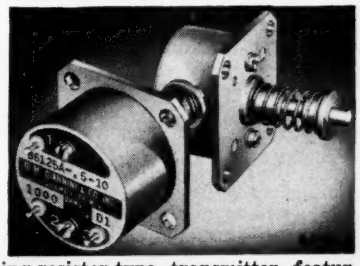
TORQUEMETER

New pressurized model of maker's "Torquometer" enables measurement of torque in rotating systems in explosive atmospheres; is available in torque ranges to 12,000 pound-inches and speeds to 15,000 rpm. Like standard line, it comprises both electrical means for measuring a torsional strain and a mechanical assembly for providing that strain.—*B & F Instruments, Inc.*, 4732 *N. Broad St., Philadelphia* 41, *Pa.*

For more information circle **334** on inquiry card.

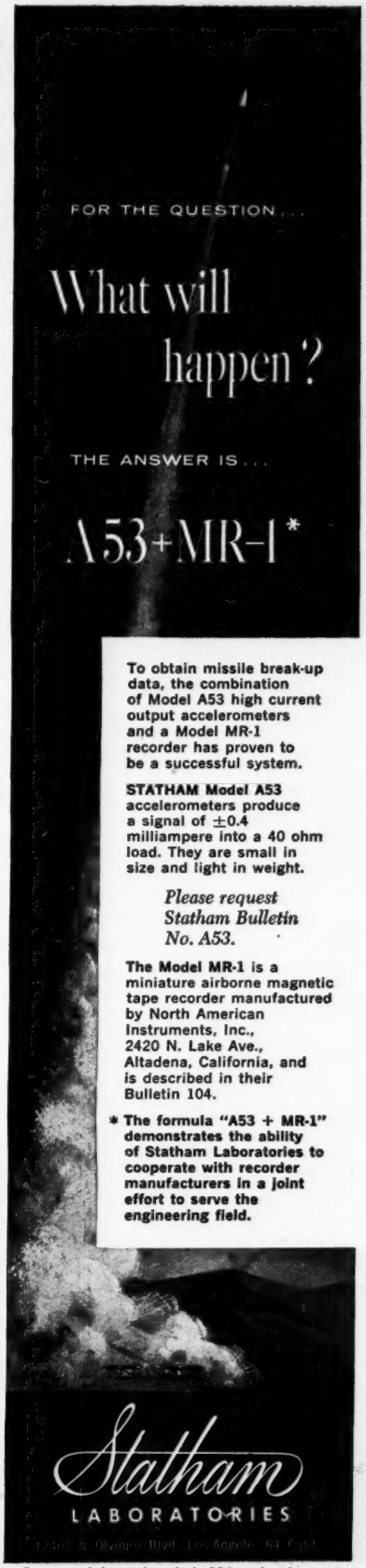
DISPLACEMENT PICKUP

New "86125A Pancake Rectipot" is a miniature spring-loaded short-stroke linear-motion precision voltage-divid-



ing-resistor-type transmitter featuring less than 1" body length for a full ½" stroke of its stainless steel shaft. Standard stroke ranges 0.1" to 0.5" in resistance ranges of 1000 and 2000 ohms with 1% linearity and 0.0012" resolution.—*G. M. Giannini & Co., Inc., Pasadena, Calif.*

For more information circle **335** on inquiry card.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What will happen?
THE ANSWER IS...
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To obtain missile break-up data, the combination of Model A53 high current output accelerometers and a Model MR-1 recorder has proven to be a successful system.
STATHAM Model A53 accelerometers produce a signal of ±0.4 milliampere into a 40 ohm load. They are small in size and light in weight.
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The Model MR-1 is a miniature airborne magnetic tape recorder manufactured by North American Instruments, Inc., 2420 N. Lake Ave., Altadena, California, and is described in their Bulletin 104.
* The formula "A53 + MR-1" demonstrates the ability of Statham Laboratories to cooperate with recorder manufacturers in a joint effort to serve the engineering field.
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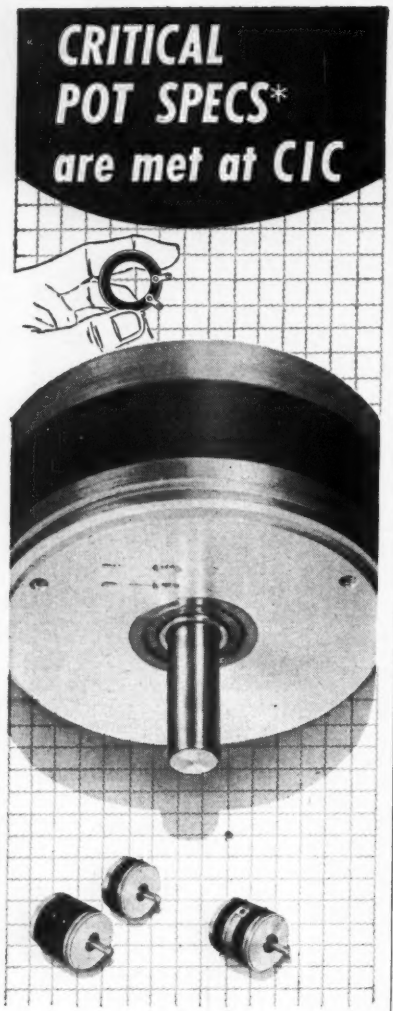
LABORATORIES

For more information circle **110** on inquiry card.



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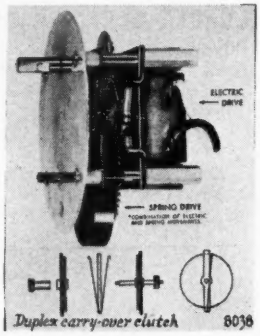
For more information circle **111** on inquiry card.

TIME, SPEED, COUNT

TWO-DRIVE TIMER

New "Duplex Time Component," claimed to be "the perfect timer" for chart driving, process timing, etc.,



keeps running when power fails or circuits short out; comprises a synchronous electric time unit and a spring-driven time unit which is held in reserve and goes into action instantly. Upon power resumption or circuit repairs, synchronous motor again takes over instantly.—*Industrial Timer Instruments Co.*, 189 *W. Madison St., Chicago* 2, *Ill.*

For more information circle **336** on inquiry card.

TIME DELAY RELAY

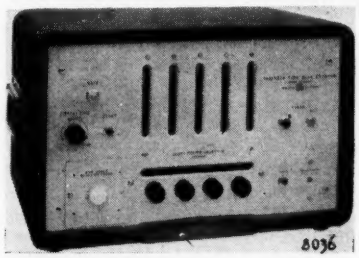
New "Model NETL Agastat" time delay relay allows electrical interlock

and two step timing; is a combination unit with two normally closed Micro switches and a basic Agastat relay. Units are available for ac or dc in sp-dt double-break, and dp-dt single-break; rated 15 amp at 115 vac.—*Elastic Stop Nut Corp. of America, A'G'A Div., Elizabeth, N. J.*

For more information circle **337** on inquiry card.

FREQUENCY COUNTER

New "DY-2500 Electronic Computing Counter," for measuring flow-rate, etc., in desired units without



time-consuming conversions, has a variable gate time that functions as a multiplier. Provision for a second input permits measuring ratios of two independent variables to obtain (for example) engine revolutions per gallon.—*Hewlett-Packard Co.*, 395 *Page Mill Road, Palo Alto, Calif.*

For more information circle **338** on inquiry card.

FREQUENCY COUNTER

New "Model 7340A," developed specifically for industrial applications, counts mechanical and electrical

events and measures their repetition rate; is said to be "ideal for such applications as rpm measurement, oscillator calibration, direct counting, and

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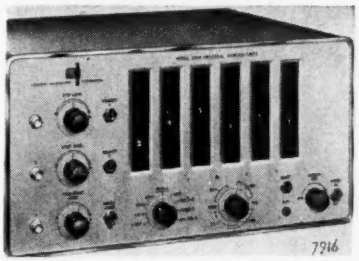
flow measurement." Automatic decimal point location; 1 to 9,999 events per second; reliable circuitry. For applications requiring a permanent record of readings, "Model 7341A" (shown) has outputs for driving a serial type print-out.—*Electro-Pulse, Inc.*, 11861 *Teale St., Culver City, Calif.*

For more information circle **339** on inquiry card.

1-MC COUNTER TIMER

New "Model 226A Universal Counter Timer" measures frequency, frequency ratio period ($1/f$) and time in-

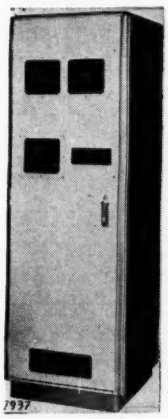


terval. Pressure, velocity, acceleration, displacement, flow, rps, rpm, etc., can be measured with suitable pick-ups. Major features: simplified color-coded controls; direct read-out in kc, Mc, seconds or milliseconds with automatic decimal point indication.—*Computer-Measurements Corp.*, 5528 *Vineland Ave., N. Hollywood, Calif.*

For more information circle **340** on inquiry card.

COMPUTING AND DATA PROCESSING

RADAR DATA PROCESSOR



New "Model 325" radar data reduction system reduces analog range, azimuth and elevation data to digital form on punched cards. Speeds of 60 readings per second on each of three independent data channels permit near continuous reading of input data or scanning of multiple data sources. Readings are made to four significant figures. — *Franklin Electronics Inc., Dept.* 151, *PO Box* 113, *Bridgeport, Pa.*

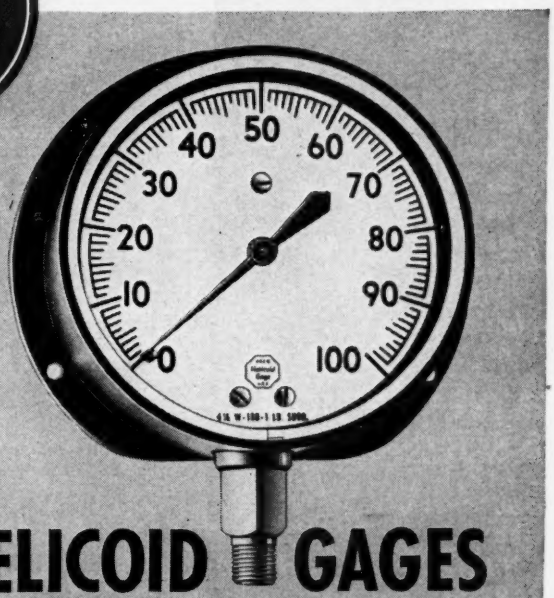
For more information circle **341** on inquiry card.

BALLISTIC FILM READER

New "Powered Comparator" features a fixed-scale measuring system. Precision lead screw and nut driving a decimal "Digitizer" provide a least count equivalent to 10 microns. All digital measurements are made at film and not on projected image, so that machine precision and scale accuracy

an ACCO product

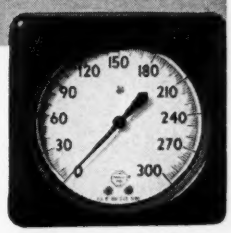
Helicoid Gages



How HELICOID GAGES can save YOU money!

LONG LIFE:

HELICOID Gages are pressure instruments of extreme precision and long, trouble-free service with minimum maintenance. Have no gear teeth to wear out.



Acaloy square flush case

SUSTAINED ACCURACY:

HELICOID Gages have many unique and exclusive features which result in the highest degree of gage accuracy. Tubes, for instance, will withstand hundreds of thousands of pressure pulsations and will not stretch, leak or crack.

JOB-DESIGNED:

HELICOID Bourdon tubes are made from seamless tubing of alloy steel, K Monel, stainless steel or phosphor bronze. Each is designed to give best service under specific conditions. Available in complete line of cases for wall or stem mounting.

Helicoid Chemical gage

Send for catalog

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value

For more information circle **112** on inquiry card.

Be
sure
you
see
the

DIGIMATIC

tape
control
system
for
machine
tools
and
the

STATISTICAL ANALYZER

automatic
handler
tester
sorter
recorder
and
analyzer
system
for
components
at
booths
156, 157 and 507

Third
International
Automation
Exposition
New York
November 26, 27, 28,
29, & 30

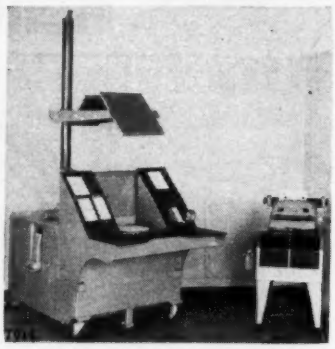
Clinics
will
be held
daily

ELECTRONIC CONTROL SYSTEMS, INC.

2136 Westwood Blvd.,
LOS ANGELES
CALIFORNIA

For more information circle **113** on inquiry card.

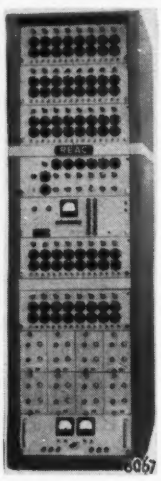
NEW INSTRUMENTS



are independent of magnification. "Digitizer" permits readout into any combination of card punches, paper tape perforators, or electric typewriters. Comparators are available to handle any configuration of film size up to 5½" wide, including film from pin-registered cameras.—*Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles* 16, *Calif.*

For more information circle **342** on inquiry card.

FUNCTION GENERATOR



New 5-channel "DFG 401 REAC Diode Function Generator" can generate functions of two or more variables; is self-contained except for relay and reference supplies; is well suited as an addition to an existing computer installation; allows direct generation of slopes up to 12 without paralleling of segments. Functions once set up can be reproduced later by resetting 1000-division dials to their previously-recorded values.—*Reeves Instrument Corp., 207 E. 91st St., New York* 28, *N. Y.*

For more information circle **343** on inquiry card.

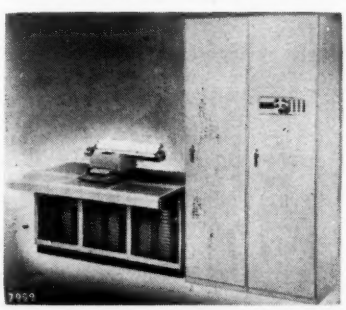
STOCHASTIC GENERATOR

New Stochastic Generator saves much time in obtaining truly random numbers; obviates need of transcribing by hand from tables or drawing numbers from a bowl. Rate of continuous generation of random numbers is 10 per second. New device can generate normal as well as rectilinear distributions.—*Loyola Labs., Box* 45074 *Airport Sta., Los Angeles* 45, *Calif.*

For more information circle **344** on inquiry card.

ELECTRONIC DATA LOGGER

New data logger incorporates advanced techniques which simplify over-all system and enhance inherent accuracy and reliability. Accuracy is conservatively guaranteed 0.2% for all inputs, including non-linear types. Reliability is claimed because of (1) complete absence of mechanical operations except for normal complement of high-quality sealed relays and (2)



Interested in

SERVOMECHANISMS?

You can learn about . .

Factors in selection of electromechanical components, including standardization of differentials, speed reducers, gears, etc.

Presented by PIC Design Corp., in Room 554

Integration of servomechanism subsystems—defining the extent of subsystem design units.

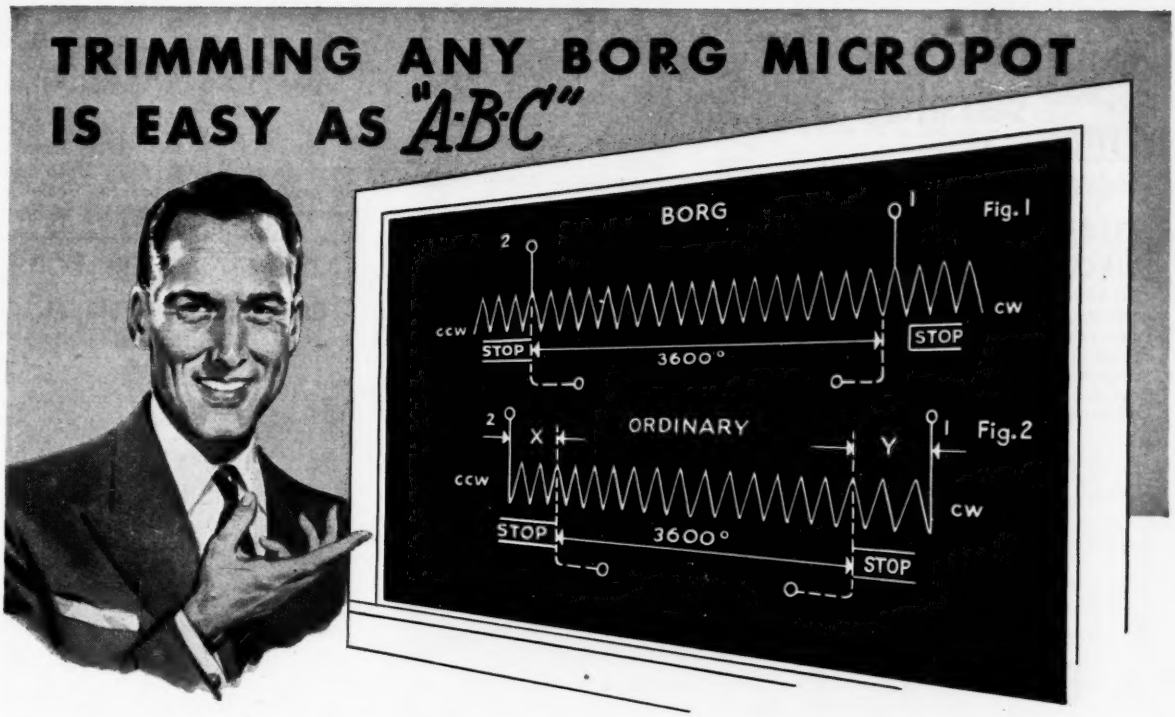
Presented by Servomechanisms, Inc., in Room 525

Working-model demonstrations of principles, components and applications of servomechanisms.

Presented by Servo Systems Company, in Room 414

at the **SERVOMECHANISMS CLINIC** at the Third Automation Exposition. See page 1970 for registration coupon.

TRIMMING ANY BORG MICROPOT IS EASY AS "A·B·C"



Borg Micropots Reduce Assembly Costs With Simplified Trimming of Borg Independent Linearity

All Borg independent linearity MICROPOT Potentiometers may be trimmed at one end only. They will then produce an output voltage within the linearity tolerance of the potentiometer.

BORG MICROPOTS

This is readily illustrated in Figure 1, on the blackboard. The mechanical stops in all Borg MICROPOT Potentiometers with independent linearity, are set beyond the position of each terminal 1 and 2. This allows the contact to travel to the last active turn at either end of the winding. Thus, by positioning the contact at one end point, trimming of that end is not required.

ORDINARY POTENTIOMETERS

Note the mechanical stops in Figure 2. This is an ordinary potentiometer. The mechanical stops are set to prevent the contact from reaching the last active turn, causing "end resistances" X and Y, at either end. Both resistances X and Y must be trimmed to produce voltage outputs within the linearity tolerance of the potentiometer.

TRIMMING COST

The fact that, in Borg MICROPOT Potentiometers, one end can be set up without trimming eliminates the selection of fixed trimming resistors for that end, as well as the time for selection and installation required by ordinary potentiometers.

The maximum portion of the total resistance at the opposite end that would require trimming in Borg MICROPOT Potentiometers is .4%. This is 20% less than in ordinary potentiometers, which substantially reduces the selection of fixed trimming resistors required for use with higher linearity potentiometers.

Lower linearity tolerances may require no trimming whatsoever at either end.

POTENTIOMETER APPLICATIONS

Definitions of potentiometer parameters vary from manufacturer to manufacturer, thus causing misconception to the user. A set of tentative standard definitions has been adapted by RETMA and all Borg MICROPOT Potentiometer tolerances are written for interpretation under these definitions.

The "Trimming Costs" economy in potentiometer application is a typical example of the savings, and in many cases superior performance, achieved through a clear understanding of manufacturing specifications and user requirements.

Write for Complete Engineering Data • CATALOG BED-A56

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC – MECHANICAL BORG EQUIPMENT — Built by Borg

For more information circle **114** on inquiry card.

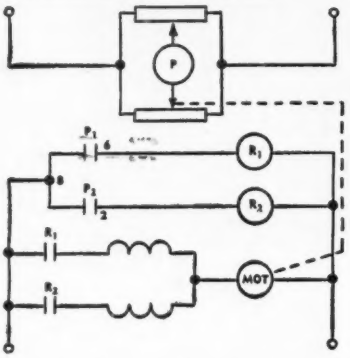
BARBER COLMAN

ultra-sensitive relays

HELPFUL DATA FOR YOUR CIRCUITRY IDEA FILE...

(No. 2 in a series by Barber-Colman Company)

The circuit drawing below indicates just one of the hundreds of ways many manufacturers are utilizing Barber-Colman Micropositioner ultra-sensitive relays to solve complex control problems. Could this be the answer to some of yours, too?



SERVOMECHANISMS APPLICATIONS

Many remote positioning applications can be solved by utilizing the Barber-Colman Micropositioner ultra-sensitive relay either as a null detector or a differential relay.

In the circuit shown above, movement of the transmitting potentiometer introduces an error signal in Micropositioner coil P, which in turn energizes the positioning motor until balance is restored. Secondary relays R_1 and R_2 operated by the Micropositioner handle larger loads. This circuit can also be applied to synchronization . . . or the Micropositioner can be utilized in the output of an electronic servo control.

Among the many applications for this simplified servo control relay are positioning of antenna rotators and tuning condensers . . . aerial camera mounts . . . valves . . . test cell apparatus.

If your projects involve servomechanisms, why not make a test with a Micropositioner designed for circuits similar to that shown above? Write for technical bulletins F7279 and F3961-5.

BARBER-COLMAN MICROPOSITIONER POLARIZED DC RELAYS

Various types...plug-in, solder-lug, screw terminal, hermetically sealed. Operate on input powers of 50 to 1,000 microwatts for use in photoelectric circuits, resistance bridge circuits, and electronic plate circuits. Send for data.

Barber-Colman Company

Dept. J, 1415 Rock Street, Rockford, Illinois

For more information circle **115** on inquiry card.

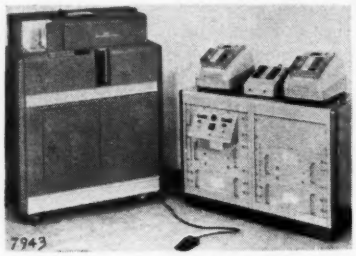
NEW INSTRUMENTS

hermetic sealing providing Class I, Division 2 classification. Digitizing is effected by sweep comparison circuits operating an electronic gate which passes discrete crystal oscillator counts to magnetic storage in decimal form.—*The Kybernetes Corp., 9 E. 40th St., New York 16, N. Y.*

For more information circle **345** on inquiry card.

MANN COMPARATOR DATA PROCESSOR

New system provides extremely accurate digital recording of both *X* and *Y* axes from a Mann Comparator.

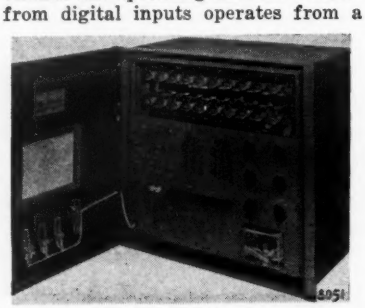


Shaft positions are digitized by means of "Datex" encoders whose output is fed into standard "Datex" modular storage and control units which translate binary code into Arabic decimal. —*G. M. Giannini & Co. Datex Div., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **346** on inquiry card.

PUNCHED TAPE CONVERTER

New addition to maker's line of converters for operating an *X-Y* Plotter from digital inputs operates from a punched tape reader; is designed to accept data from output punched paper tape of "Electrodata Datatron Computer" but can be modified to operate with any other digital computer furnishing a paper tape output such as maker's "LGP-30." (If a printed listing is desired in addition to the plot, unit can be operated from a tape-actuated typewriter.)—*Librascope, Inc., Glendale 1, Calif.*



For more information circle **347** on inquiry card.

DATE AND TIME SIGNAL GENERATOR

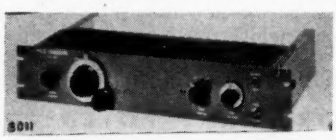
New date and time signal generator, for data logging or communication systems, provides a Teletype line

signal consisting of day, month, year, hour, and minute and a number of other preset characters on demand. A separate neon lamp panel is available for remote indication of clock setting. ★ Variation of signal generator can accumulate a count, such as "barrels delivered" (up to 999999) and then transmit this total on demand.—*L and R Products, 52 Lake Road, Framingham, Mass.*

For more information circle **348** on inquiry card.

PULSE GENERATOR

New "Type 1050" is a stable source of pulses usable in digital techniques at extra-high frequencies; has independent controls for pulse frequency, duration, amplitude, and polarity. Output is a ½ sinewave covering an adjustable range from 1.6 to 10.4 Mc in four overlapping bands; pulse



Want to know more about **ELECTRONIC, HYDRAULIC, PNEUMATIC AND ELECTROMECHANICAL TECHNIQUES?**

You can learn about . . .

Analyzing applications for pneumatic and hydraulic equipment in automatic operations. *Presented by Modernair Corp., in Room* 343

Ultrasonic techniques for gaging, inspection, flaw detection, and cleaning. *Presented by Branson Ultrasonic Corp., in Room* 548

Application of scopes and scanners to automatic control systems, e.g. flaw detection in continuous processing. *Presented by Allen B. Du Mont Labs., in Room* 339

Characteristics and applications of syncroverters, choppers and high-speed relays in automation. *Presented by Bristol Company, in Room* 301

TV and wide-band data transportation and distribution systems, and remote control equipment. *Presented by Jerrold Electronics Corp., in Room* 407

at the **CLINIC FOR ELECTRONIC, HYDRAULIC, PNEUMATIC, AND ELECTROMECHANICAL TECHNIQUES** at the Third International Exposition. See page 1970 for registration coupon.

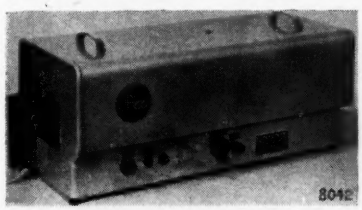
width adjustable from 0.03 to 0.07 usec in five bands; amplitude adjustable from 10 to 32 v with either polarity.—*Burroughs Corp., Electronic Instruments Div.*, 1209 *Vine St., Philadelphia 7, Pa.*

For more information circle **349** on inquiry card.

LABORATORY EQUIPMENT

SCANNING SPECTROMETER

New "Model 8200 Jaco-Ebert" low-cost 0.5-m grating type scanning spectrometer, said to surpass conven-

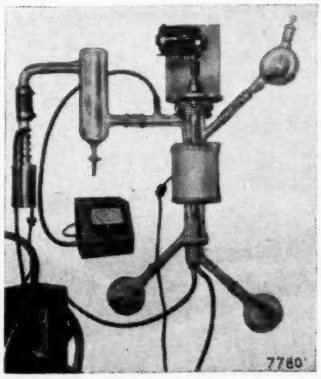


tional instruments in "both dispersion and resolution," features first-order reciprocal linear dispersion of 16 Angstroms/mm at exit slit, minimum resolution 0.2 Angstroms; is easily adapted for use as a flame spectrometer; can detect impurities to one part per billion. Among features is a linear wave-length scanning mechanism which requires only a Veeder-Root counter.—*Jarrell-Ash Co.*, 26 *Farwell St., Newtonville* 60, *Mass.*

For more information circle **350** on inquiry card.

MOLECULAR STILL

New simplified two-inch version of "Rota-Film Molecular Still" offers a relatively inexpensive method of



molecular distillation for user who does not require great capacity of full-size models; is especially useful as their lab counterpart since results can be duplicated on any commercial scale.—*Arthur F. Smith Company, Rochester* 3, *N. Y.*

For more information circle **351** on inquiry card.

LABORATORY STIRRER

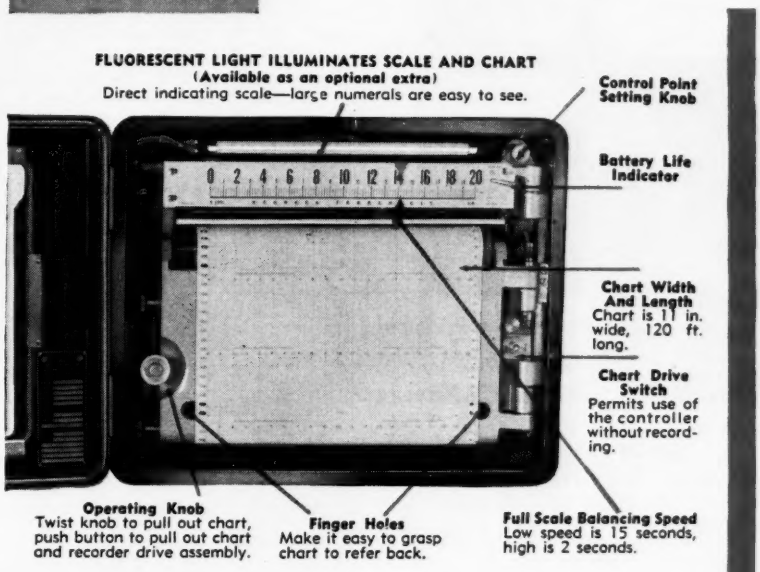
New "#69" stirrer can also serve as a shaker drive for Van Slyke apparatus and separator funnel extractions. Maximum output torque 1 to 2 pound-inches; 10:1 bronze gear re-

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

New Series 8000 Potentiometer-Recorder .. tops in accessibility and ease of adjustment


FLUORESCENT LIGHT ILLUMINATES SCALE AND CHART
(Available as an optional extra)
Direct indicating scale—large numerals are easy to see.
Control Point Setting Knob
Battery Life Indicator
Chart Width And Length
Chart is 11 in. wide, 120 ft. long.
Chart Drive Switch
Permits use of the controller without recording.
Operating Knob
Twist knob to pull out chart, push button to pull out chart and recorder drive assembly.
Finger Holes
Make it easy to grasp chart to refer back.
Full Scale Balancing Speed
Low speed is 15 seconds, high is 2 seconds.

Accessibility and ease of adjustment were primary design considerations when Wheelco developed the new Series 8000 Potentiometer-Recorder. While every Wheelco instrument is built to function with maximum accuracy and minimum maintenance, this new null-balancing type electronic recorder was designed to be especially easy to use.

The front cover swings open 180 deg, thus permitting the chart drive to swing out a similar 180 deg, making the internal mechanism accessible. Wheelco Series 8000 Potentiometer-Recorder is available to measure, indicate, control, and give permanent record of variables such as temperature, speed, strain, hydrogen ion (pH), and any other quantities which can be resolved into electrical signals.

Send for new catalog which gives complete technical information on this latest Wheelco instrument.

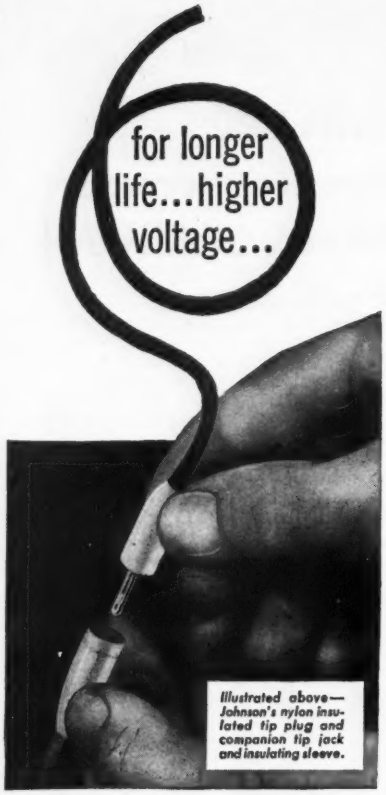
WHEELCO INSTRUMENTS DIVISION

Barber-Colman Company

Dept. J, 1515 Rock Street, Rockford, Illinois

BARBER-COLMAN of CANADA, Ltd., Dept. C, Toronto and Montreal, Canada

For more information circle **116** on inquiry card.



Illustrated above—Johnson's nylon insulated tip plug and companion tip jack and insulating sleeve.

Solderless Nylon Connectors

(Available in 11 bright colors)

- Shock-proof nylon sleeves—won't chip or crack with the hardest usage.
- Excellent for high voltage applications.
- Highly resistant to extremes of heat, cold and moisture.
- Tip and banana plugs designed for simplified solderless connection of up to 16 gauge stranded wire. Jacks require soldered connection.
- Economical—simple, functional design gives you top quality at low cost.

SPECIFICATIONS

BANANA PLUG—Nickel-plated brass construction with nickel-silver springs. Spring plug is .175" diameter, fits all standard banana jacks.

TIP PLUG—Recessed metal head is fully insulated. Metal parts are brass, nickel-plated. Pin is .081" diameter—fits all standard tip jacks.

NYLON TIP JACK AND INSULATING SLEEVE—Complete assembly includes standard nylon tip jack with threaded nylon insulating sleeve. Ideal for patch cords or for panel mounting where an insulated rear connection is desired.

Write for samples, prices and further information.

Pilot Lights

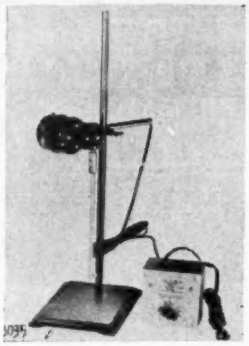
Available in a wide variety of types; Johnson Pilot Lights are stocked by parts distributors throughout the country. Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass and lucite jewels in clear, red, green, amber, blue, or opal lenses. Specials, including those meeting military specifications are also available in production quantities. For full information, write to:

E. F. Johnson Company

2708 SECOND AVE. S.W. • WASECA, MINN.

For more information circle **117** on inquiry card.

NEW INSTRUMENTS

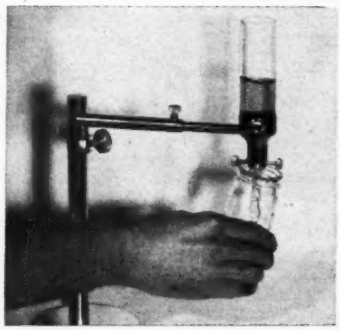


ducer; 100 to 1200 rpm in eleven steps. Tapped autotransformer gives better speed regulation than a rheostat without heat loss.—*Gerald K. Heller Co., 1 N. Carey St., Baltimore 23, Md.*

For more information circle **352** on inquiry card.

SPECIFIC-GRAVITY TESTER

New "Graviometer," for making rapid specific-gravity measurements in lab without technician's hands com-

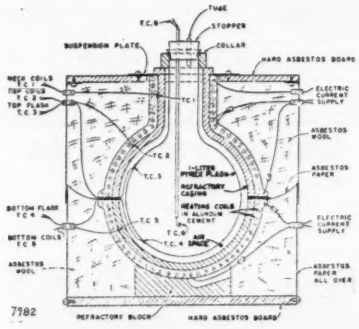


ing in contact with the fluid, has particular usefulness in measurement of acids, milk, urine, etc.—*Royco Instruments, 818 Arthur St., Albany, Calif.*

For more information circle **353** on inquiry card.

SELF-IGNITION APPARATUS

New "Setchkin Self-Ignition Apparatus," for testing spontaneous ignition temperatures of combustible



liquids, comprises an insulated spherical flask, designed to provide conditions favorable to low ignition temperature values; is well insulated to prevent heat loss; is capable of obtaining reproducible results.—*Research Appliance Co., Box 307, Allison Park, Penna.*

For more information circle **354** on inquiry card.

COMBUSTION BOATS

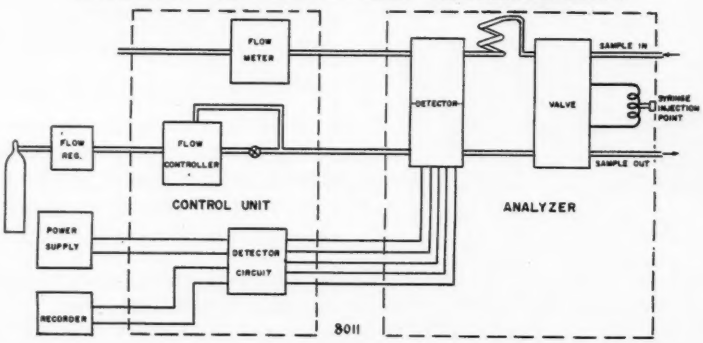
New improved heavy-duty combustion boats, made of highest available grade zircon silicate, are heat-shock resistant, carbon- and sulphur-free, and resist penetration of stainless steel and silicon steel slags. Standard sizes stocked for immediate shipment.—*Saxonburg Ceramics, Bock St., Saxonburg, Pa.*

For more information circle **355** on inquiry card.

LAB VOLTAGE REGULATOR

New "Model MXP-3000" all-magnetic 400-cycle ac line voltage regulator delivers a sinoidal output despite ac input distortions; is said to "fill a long-standing laboratory need for equipment that can maintain a con-

RESEARCH AND ANALYTICAL CHROMATOGRAPH



New "Type 26-201" vapor phase chromatograph, developed for use in research and analytical labs, utilizes elution method; will handle a wide variety of compounds including liquids with boiling points up to 325°C. Versatility: ability to use micro-samples and to operate with adsorption, gas-liquid partition, and reaction columns; ability to separate closely boiling isomers as well as components in wide-boiling-range mixtures; modular design for future expansion.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **356** on inquiry card.

HEISE GAUGES

Precision . . . begins behind the dial

Behind the dial of the Heise gauge lies an instrument known throughout the world for high precision and dependable service under the most demanding conditions.

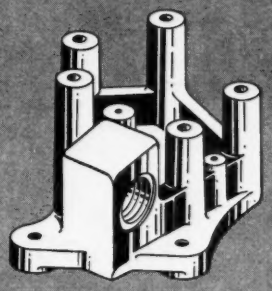
Accurate and dependable performance requires simplicity of design, rigidity of supporting structure and firmly integrated mechanism.

These features appear in their most highly developed form in the Heise gauge.

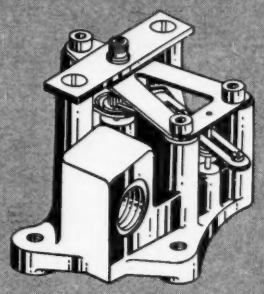
The Heise integral movement consists of a solid, massively designed bronze casting which with a one piece cover plate completely contains and supports all moving parts of the gauge. The dial and case are each independently mounted on this casting and completely isolated from the movement.

The Bourdon Tube in the Heise gauge is of weldless one piece construction, an exclusive Heise feature, and is custom designed to provide a length width ratio for optimum performance in each specific application.

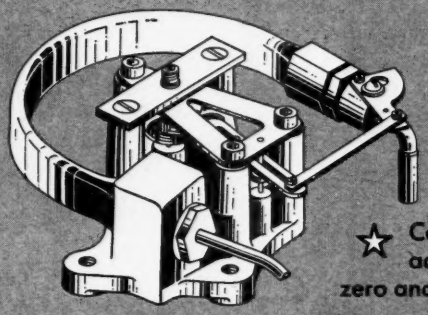
- Massive bronze base
- Tube socket integrally cast



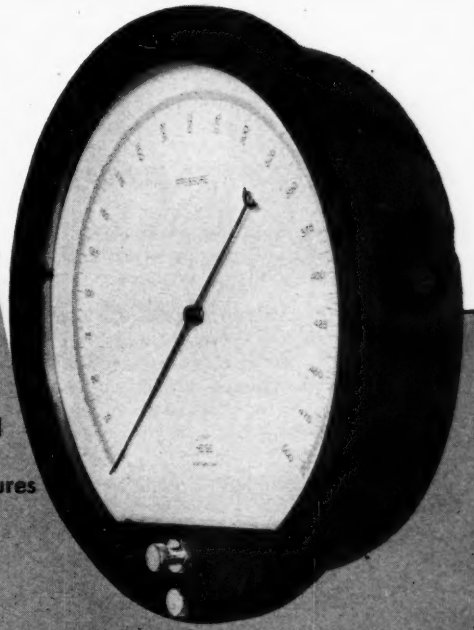
- Main frame completely contains precision machined integral movement
- Dial mount and pivot supported from base isolates dial from movement



- Special sleeve bushings isolate pressure medium from tube socket
- One piece weldless Bourdon Tube machined from solid stock
- Designed to eliminate Hysteresis and Creep



- Patented External Bleeder
- Convenient external adjustment of dial zero and many other features



DELIVERY WITHIN 30 DAYS

Pressure Range 15 to 20,000 P.S.I.

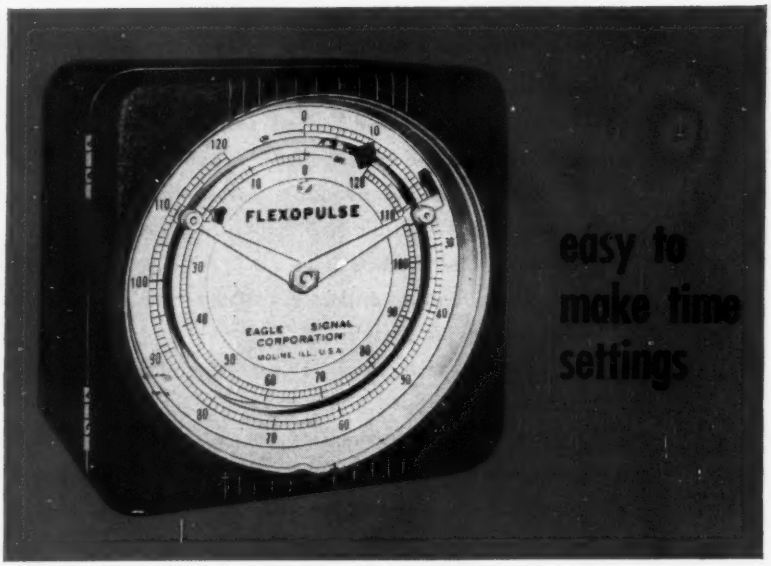
Dial Sizes 8½"-12"-16"—Prices from $151.60

HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

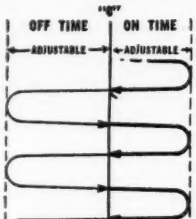
EAGLE FLEXOPULSE repeat cycle timer

WITH S.P.D.T. SWITCH



No gear change or resetting of cams required

This Flexopulse Repeat Cycle Timer is ideal for controlling processing machines requiring adjustable timed cycles. The "on" or "off" intervals are easily adjusted. Either can be adjusted without disturbing the setting of the other. Instead of resetting cams or changing gears, simply loosen two knurled nuts. Then set "on" and "off" periods by moving two adjustable arms. Tighten screws, and the job's done.



HAS CYCLE PROGRESS INDICATION:

A movable flag indicator passing over the time scale between adjustable arms, indicates portion of cycle elapsed in either of the s.p.d.t. positions. Switching operation takes place at zero.

Flexopulse is ideal for periodically operating valves to reverse the flow of liquids, for operating signals or for injecting chemicals. 120-second up to 20-hour dials are available. Synchronous motor powered. Send coupon today for free bulletin 320.

FREE BULLETIN, MAIL COUPON

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. IA-1056
MOLINE, ILLINOIS

Please send free Bulletin 320 with full data on Flexopulse Repeat Cycle Timer.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

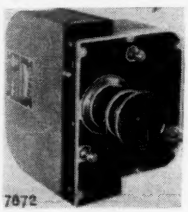
For more information circle **119** on inquiry card.

stant 400-cps line voltage regardless of line or load variations," also eliminates interference between sections of a lab where a single 400-cps supply is used. Time response 10 milliseconds for 100% load change; static regulation 0.5 v from 395 to 405 cps and 1 v from 380 to 420 cps. Load can be varied from 0 to 25 amp without changing output voltage more than stated amount. Output voltage continuously adjustable between 110 and 120 v; no danger of output overvoltages.—*Magnetic Research Corp.*, 200 *Center St., El Segundo, Calif.*

For more information circle **357** on inquiry card.

PHOTOGRAPHY

35-MM RECORDING CAMERA

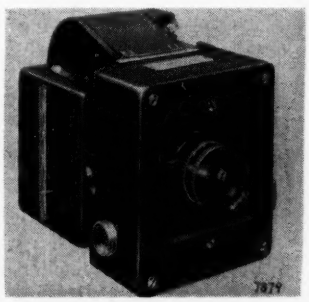


New "Type 232 MK7 Instrumentation Camera" is said to have been designed as "the most flexible camera in the field of instrumentation and air photography." Feature: Main components and assemblies are designed on module system to make conversion simple. Magazine takes 100 ft 35mm standard sprocketed film, No. 10 daylight loading spool. (400 ft. magazine on special order). Interval time 3 cps maximum.—*Norden-Ketay Corp.*, 99 *Park Ave., New York, N. Y.*

For more information circle **358** on inquiry card.

RECORDING CAMERA

New model of "Beattie Varitron Model D" instrumentation camera features front mounting to facilitate

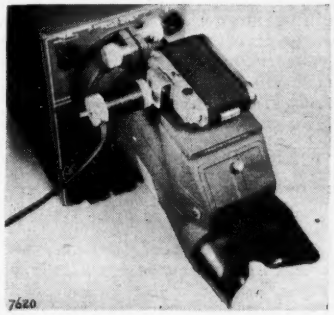


rigid mounting to structures; comes with a group of interchangeable lenses in focusing mounts. About twenty types of 35mm and 70mm film size magazines. Provision is also made to attach standard supplementary data recording system to record one or all of: time (sweep-second-hand clock); sequence of numbers (electric counter); and information (written).—*Photographic Products Inc.*, 1000 *No. Olive St., Anaheim, Calif.*

For more information circle **359** on inquiry card.

OSCILLOGRAPH CAMERA

New "Type 352" oscillograph record camera for single-frame recordings automatically advances film

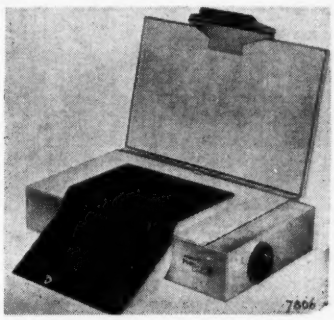


frames in rapid sequence, at random, or at synchronized intervals; has a seven-element Wollensak f/1.5-50-mm lens; uses standard 35-mm film.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **360** on inquiry card.

BOOK COPIER

New "Apeco Panel-Lite Copier," especially designed to copy pages from books and magazines (as well

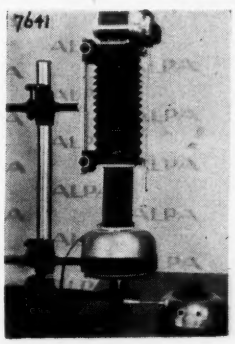


as other material requiring a flat-bed printer); has a built-in automatic timer.—*American Photocopy Equipment Co., 1920 W. Peterson Ave., Chicago 26, Ill.*

For more information circle **361** on inquiry card.

CLOSE-UP STAND

New "Alpa-Macrostat" copying and close-up stand is said to be "of amazingly flexible application in copying



every lab NEEDS one!

OHAUS Cent O Gram

ideal for:

- GENERAL LABORATORY WEIGHINGS
- A PREWEIGHER to speed results and save wear and tear on analytical balances.
- CAPACITY . . . 311 gram
- SENSITIVITY . . . .01 gram (1 centigram)

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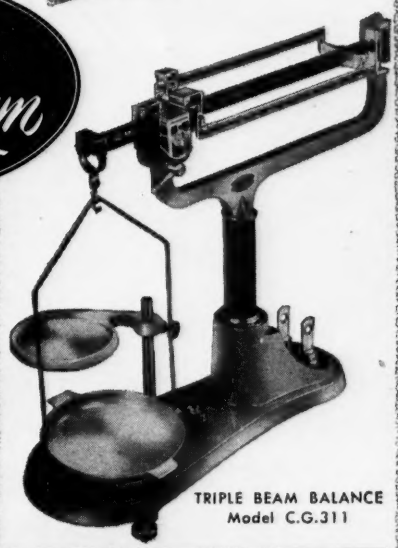
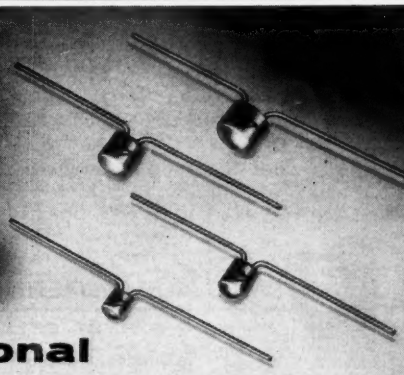


TRIPLE BEAM BALANCE
Model C.G.311

OHAUS
SCALE CORPORATION
1050 COMMERCE AVE.
UNION, NEW JERSEY

For more information circle **120** on inquiry card.

For limited space applications...



International subminiature selenium diodes

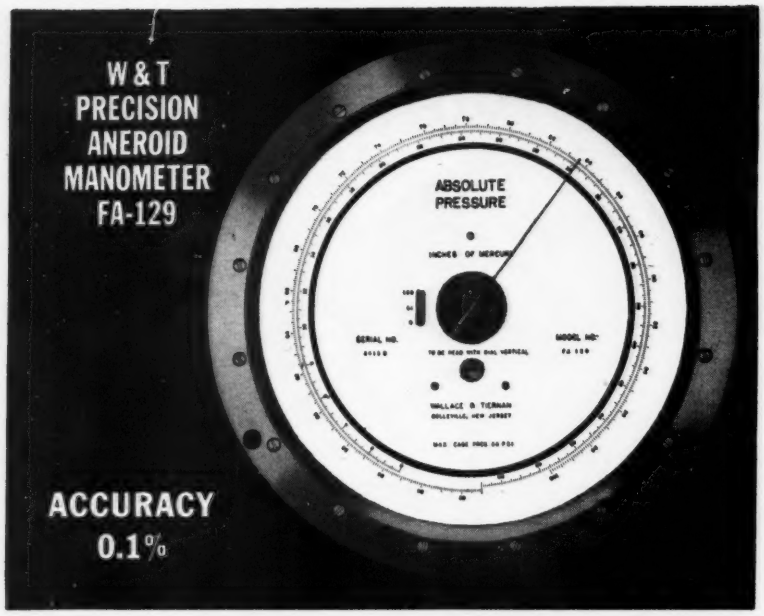
These subminiaturized and ruggedized selenium diodes are produced to withstand the most rigid environmental requirements. Encapsulated within a thermosetting plastic for complete protection, they offer stable operation in a temperature range from −50°C to +100°C, with output voltages from 20 to 160 volts and output currents from 100 microamperes to 11 milliamperes.

A WORLD OF DIFFERENCE ... THROUGH RESEARCH

International Rectifier
CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

For more information circle **121** on inquiry card.



PRECISE CALIBRATING STANDARD
...For Absolute Pressure Work

Ranges: 0 to 31.5 inches of Hg. absolute (min.)
0 to 100 inches of Hg. absolute (max.)
Other intermediate ranges available

Accuracy: 1/1000 of full scale

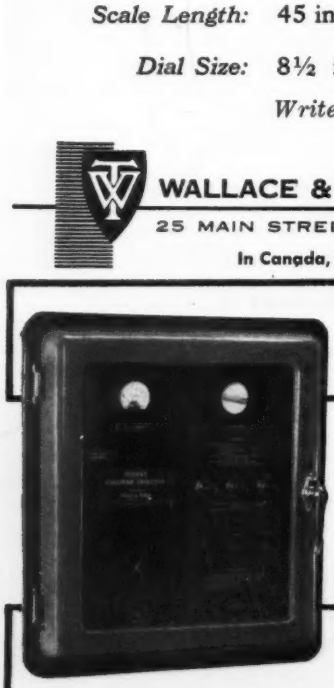
Sensitivity: 1/10,000 in *all* ranges

Scale Length: 45 inches in two revolutions

Dial Size: 8½ inch diameter

Write for Publication No. TP-15-A

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto A-112



HOW TO DETECT 3 PARTS CHLORINE IN A MILLION PARTS AIR

New W&T Solvay Chlorine Detector*
detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.

Write for Publication 50.118

WALLACE & TIERNAN
INCORPORATED
25 MAIN ST., BELLEVILLE 9, N. J.

I-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

For more information circle **122** on inquiry card.

NEW INSTRUMENTS

prints, posters, or pages; in reproducing small objects like stamps, coins, or gems to exact scale; in obtaining large-scale close-ups of flowers or insects in their natural habitat—and many other uses."—*Karl Heitz Inc., 480 Lexington Ave., New York 17, N. Y.*

For more information circle **362** on inquiry card.

NUCLEONICS

HEALTH MONITOR

New "Radiameter" (German-made) detects and measures potentially hazardous atomic radiation in industry

or x-rays in medicine, weighs 2 lb; fits into a suit coat pocket; operates on a flashlight battery. Its simplicity enables plant personnel to make checks with minimum supervision from the health physicist or industrial hygienist.—*Curtiss-Wright Corp., Electronics Div., Carlstadt, N. J.*

For more information circle **363** on inquiry card.

FOR AIRCRAFT AND MISSILES

RECORDER FOR MISSILES

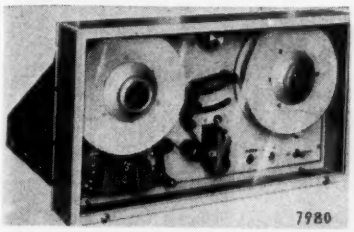
New "Event Recorder." for missile use, features ability to withstand severe shock. (In test it has recorded

through shocks in excess of 3000 *G.*) It weighs less than 6 lb; can record up to 21 channels on electrosensitive papers. Various chart speeds available. Governor-controlled motor available for battery operation.—*Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio.*

For more information circle **364** on inquiry card.

AIRBORNE MAGNETIC TAPE HANDLERS

New "Model 3186," for operation on either 60- or 400-cps power, uses standard 1" wide magnetic tape with

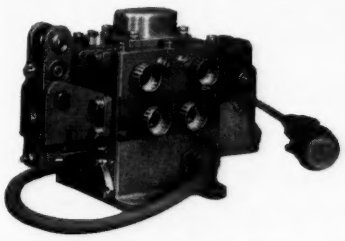


an interlaced head stack arrangement that provides 25 data channels. Tape speed 54 ips on standard models; other tape speeds can be accommodated. Tape travel can be controlled by front panel switch or remotely.—*Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, N. Y.*

For more information circle **365** on inquiry card.

POSITION-SERVO VALVE

New dual input servo valve for aircraft surface positioning employs a new summation principle; combines

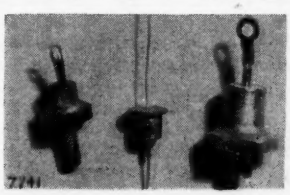


artificial flight stability augmentation and work of autopilots with pilot boost servos (usually mechanohydraulic); permit direct mechanohydraulic flight control, combined mechanohydraulic and electrohydraulic control, and electrohydraulic control alone. Full mechanical override for safety is always possible and self-contained solenoid and lock-out arrangements permit full flight mode selection.—*Moog Valve Co., East Aurora, N. Y.*

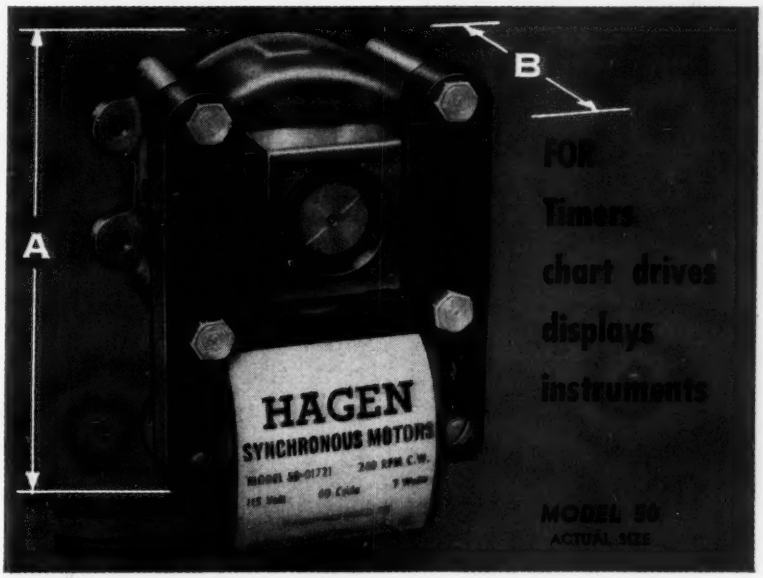
For more information circle **366** on inquiry card.

SILICON POWER RECTIFIERS

New line of silicon power rectifiers is said to be ideally suited for airborne electronic equipment, also wherever minimum size, high operating temperature and resistance to vibration and shock are required. Electrically, new units exhibit exceptionally low forward voltage drop when passing full



HAGEN Synchronous motors



most powerful for its size

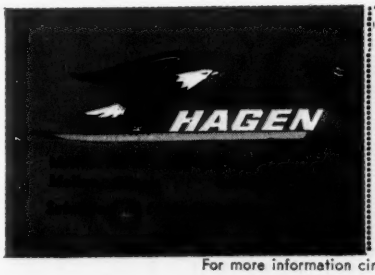
Laminated rotor construction of the Model 50 Hagen Motor produces exceptionally high torque. For example, the rotor develops 10 ounce inches torque at 4 RPM. This motor is ideal for those applications requiring from 5 to 10 times the power of clock-type miniature motors. Yet in spite of its power, the motor is extremely compact:

DIMENSIONS

	50 to 60 cycle	25 cycle
	3-3/32	3-1/16
	1-13/32	1-23/32

Just a few of the many possibilities for use are: door chimes, laundry timers, depth finders, animated displays, heating controls, program clocks, fire alarm systems, integrators, time switches, chart drives, scoreboards, potentiometer drives. Motor may be mounted in any position. Wide selection of output speeds from 1800 to 1/6th RPM. Reversible and other models available. Send coupon for Bulletin No. 1055.

MAIL COUPON TODAY



HAGEN MANUFACTURING COMPANY, INC.
Dept. IA-1056, Moline, Illinois

Please send Bulletin 1055 on Hagen Synchronous Motors.

NAME AND TITLE

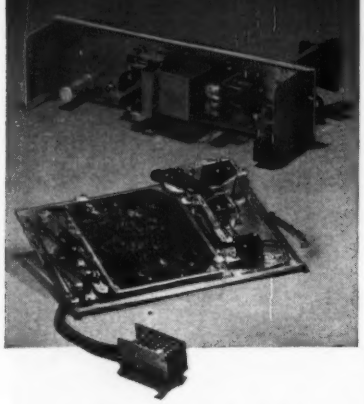
COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **123** on inquiry card.

NOW YOU CAN BUY
MAGNETIC TAPE
Recorders
AND
Announcers



designed for industrial applications and made by STROMBERG-CARLSON

When you learn what telephone companies do with these products, a dozen applications to *your* problem will come to mind.

The XY Tape Recorder is used in connection with long-distance telephone calls for recording data on a sequential basis, and later reading out the information at very high speed. Mighty useful in data processing.

The Tape Announcer is used to substitute a pre-recorded message for interception by a telephone operator—in cases like wrong numbers dialed, discontinued numbers and the like. It can be used in conjunction with any communication system.

FREE catalog will be sent on request. Or write us regarding any specific problem you have right now.

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113 CARLSON ROAD, ROCHESTER 3, N. Y.
For more information circle **124** on inquiry card.

NEW INSTRUMENTS

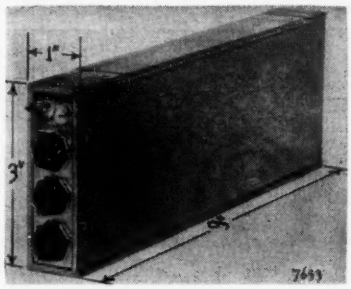
rated forward current; and negligible leakage current.—*Federal Telephone & Radio Co., Components Div., 100 Kingsland Rd., Clifton, N. J.*
For more information circle **367** on inquiry card.

TIME BASE

New "Chronopulse," said to represent "an entirely new concept in chronometric governed time base . . . revolutionary development," is basically a pulse generator, providing a precise time base (millisecond accuracy) for use in dc voltage applications. It is a miniature modular component adaptable to multiple design applications; withstands extreme environmental conditions to provide accuracy and reliability as a timing unit for event, program or sequence in jet, rocket or missile operations.—*Abrams Instrument Corp., 606 E. Shiawassee St., Lansing 1, Mich.*
For more information circle **368** on inquiry card.

SUPPLY FOR AIRBORNE USE

New subminiature power supply features unique transformer design and use of silicon rectifiers to insure

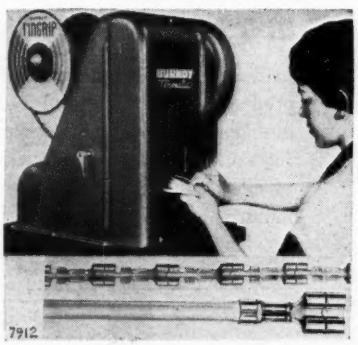


high temperature operation in a small 36-oz package. With 115-vac 400-cps input, it provides 160 vdc at a nominal 100 ma and 6.3 vac at 5 amp.—*Land-Air, Inc., Oakland Airport, Oakland, Calif.*
For more information circle **369** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

TERMINATION MACHINE AND QUICK-DISCONNECT TERMINAL

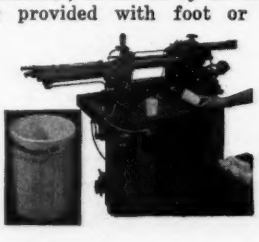
New "Termatic" automatically connects wire sizes 22 through 12 to new "Fingrip" quick-disconnect terminal;



features less-than-15-second loading time; rate of 6000 an hour; no pedals or levers to press and no pre-positioning of wire: wire insertion actuates machine.—*The Burndy Engineering Co., Inc., Norwalk, Conn.*
For more information circle **370** on inquiry card.

MARKING MACHINE

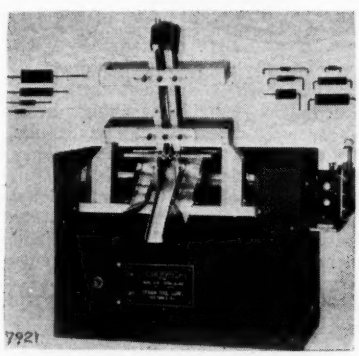
New "Model 9AH" marking machine with strength to mark steel, etc., is adaptable for marking of plastics with no change-over except slight adjustments; is driven by an air cylinder provided with foot or hand



valve (which, in high production lines, can be electrically controlled).—*The Acromark Co., 543 Morrell St., Elizabeth 4, N. J.*
For more information circle **371** on inquiry card

PIGTAIL FORMING MACHINE

New "Lead Bender" automatically prepares 14,000 axial leads per hour, bending them to right angles and cut-

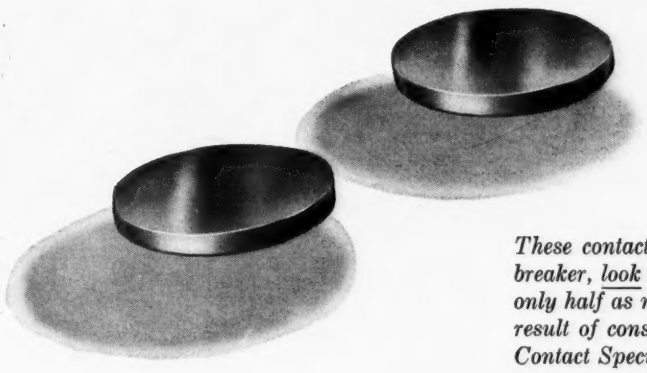


ting them to any length, equal or unequal. Easy adjustments permit rapid changes so that short runs don't waste production time.—*Design Tool Corp., 80 Washington St., New York, N. Y.*
For more information circle **372** on inquiry card.

TUBE & BELLOWS MATERIAL

New special tubing for constant elasticity applications is made from "Ni-Span C", a nickel-chrome-titanium alloy developed by The International Nickel Co. Among characteristics: constant modulus of elasticity in temperature range from −50 to 150°F making it useful for Bourdon tubes, etc.; high strength combined with unusually low drift; low hyster-

MALLORY



These contacts, for a utility circuit breaker, look alike . . . but one costs only half as much as the other, as a result of consultation with Mallory Contact Specialists.

How Mallory Contact Engineering Balances Performance and Price

Mallory Contact Engineering Offers Five Ways To Improve Economy

1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy *actual* service conditions.
2. **The most economical contact design . . .** for your purchasing, production and product needs.
3. **The most economical backing material** . . . from a group of Mallory alloys developed for this use.
4. **The most economical backing member design** . . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

CONTACTS can be *too good* for their intended service. Detailed study of a contact application, by Mallory engineers, often uncovers ways to design more closely to actual requirements . . . at substantial savings to the customer.

The contact pictured above is a typical example. Intended for use in a circuit breaker for utility distribution lines, it originally was designed with contacts made of heavy-duty silver ELKONITE®. At first glance, this exceptionally long-wearing, high conductivity metal appeared ideal to meet the customer's original specifications. But further investigation by Mallory contact engineers revealed that while contacts had to operate with absolute dependability, they did not have to function *frequently*.

On the basis of the actual frequency of service expected, Mallory engineers recommended a change to a copper ELKONITE . . . an alloy made of lower priced materials, and more economical to produce. Overall savings to this customer amounted to a 50% cut in contact costs. Moreover, there is no sacrifice in performance for the specific application.

Chances are that consultation by Mallory on your own contact applications can prove the source of interesting savings for you. Mallory engineers are well qualified by years of experience to analyze your requirements, to recommend materials from the extensive line of Mallory alloys, and to assist in overall design of contacts and assemblies. For a discussion, write or call Mallory today.

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For more information circle **125** on inquiry card.

SAVE DESIGNING AND MANUFACTURING TIME
with these
Standard COMPONENTS
FOR *Special* MACHINES

COMPLETE your *special* production equipment faster with *standard* components from this extensive line. Highest precision and quality—many sizes available from stock. *Get complete details!*

STANDARD
Slide ASSEMBLIES

Available in 52 types and sizes. *Basic Type* includes male and female members, gib and gib screws. *Assembled Type* also has return springs, stop screw, Neoprene shield and mounting holes. Sliding surfaces furnished either *Milled* or *Hand Scraped.* Widths from 2″ to 6″—lengths from 3″ to 16″.

STANDARD
Spindle ASSEMBLIES

Available in *Collet Type* for ⅛″, 3/16″ and ¼″ max. capacity collets; *Morse Taper Type* for No. 0 and No. 1 Morse taper shanks; and *Arbor Type* for shankless cutters with 0.375″ and 0.500″ center hole. *Standard Duty* has single row ball bearings at both ends; *Heavy Duty* has double row bearings at front.

WRITE now for FREE catalog!

RUSSELL T. GILMAN, Inc.
625 Beech Street
GRAFTON, WISCONSIN

For more information circle **126** on inquiry card.

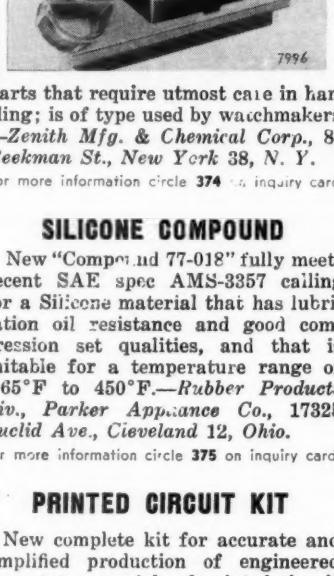
NEW INSTRUMENTS

esis; uniform thermal expansion making it useful for instrument bellows, magnetostriction devices, etc.—*Superior Tube Co., 1564 Germantown Ave., Norristown, Pa.*

For more information circle **373** on inquiry card.

PARTS CLEANERS

New "Instro-Met Strong Boy" industrial cleaning machine cleans small precision instrument and machine



parts that require utmost care in handling; is of type used by watchmakers. —*Zenith Mfg. & Chemical Corp., 82 Beekman St., New York 38, N. Y.*

For more information circle **374** on inquiry card.

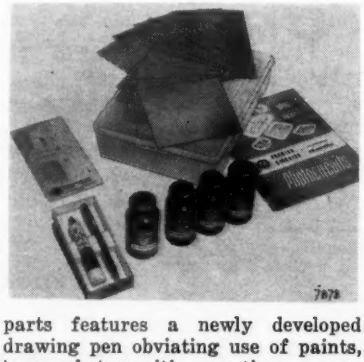
SILICONE COMPOUND

New "Compound 77-018" fully meets recent SAE spec AMS-3357 calling for a Silicone material that has lubrication oil resistance and good compression set qualities, and that is suitable for a temperature range of −65°F to 450°F.—*Rubber Products Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.*

For more information circle **375** on inquiry card.

PRINTED CIRCUIT KIT

New complete kit for accurate and simplified production of engineered or prototype models of printed circuit



parts features a newly developed drawing pen obviating use of paints, tape, photosensitive coatings, negatives, etc. At least a dozen circuits can be produced with materials in new kit.—*Photocircuits Corp., Glen Cove, N. Y.*

For more information circle **376** on inquiry card.

ELECTRIC PEN

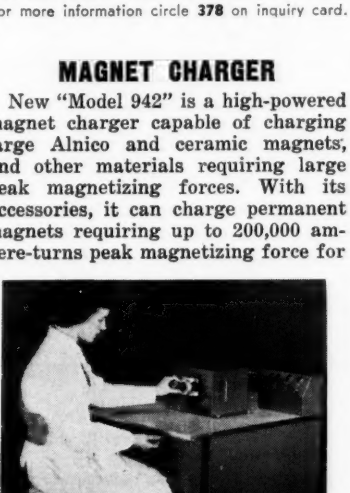
New "Actograp" will efficiently arc-etch any ferrous or non-ferrous metal. Marking can only be removed by

grinding, filing or destroying article. Exclusive control permits instrument to etch with lightness of a fountain pen.—*Newage International, Inc., 222 York St., Jenkintown, Pa.*

For more information circle **377** on inquiry card.

SCREW-HOLDING DRIVER

New screw-holding driver prevents dropping screws, saves time and cuts costs. Exclusive twin bits expand to

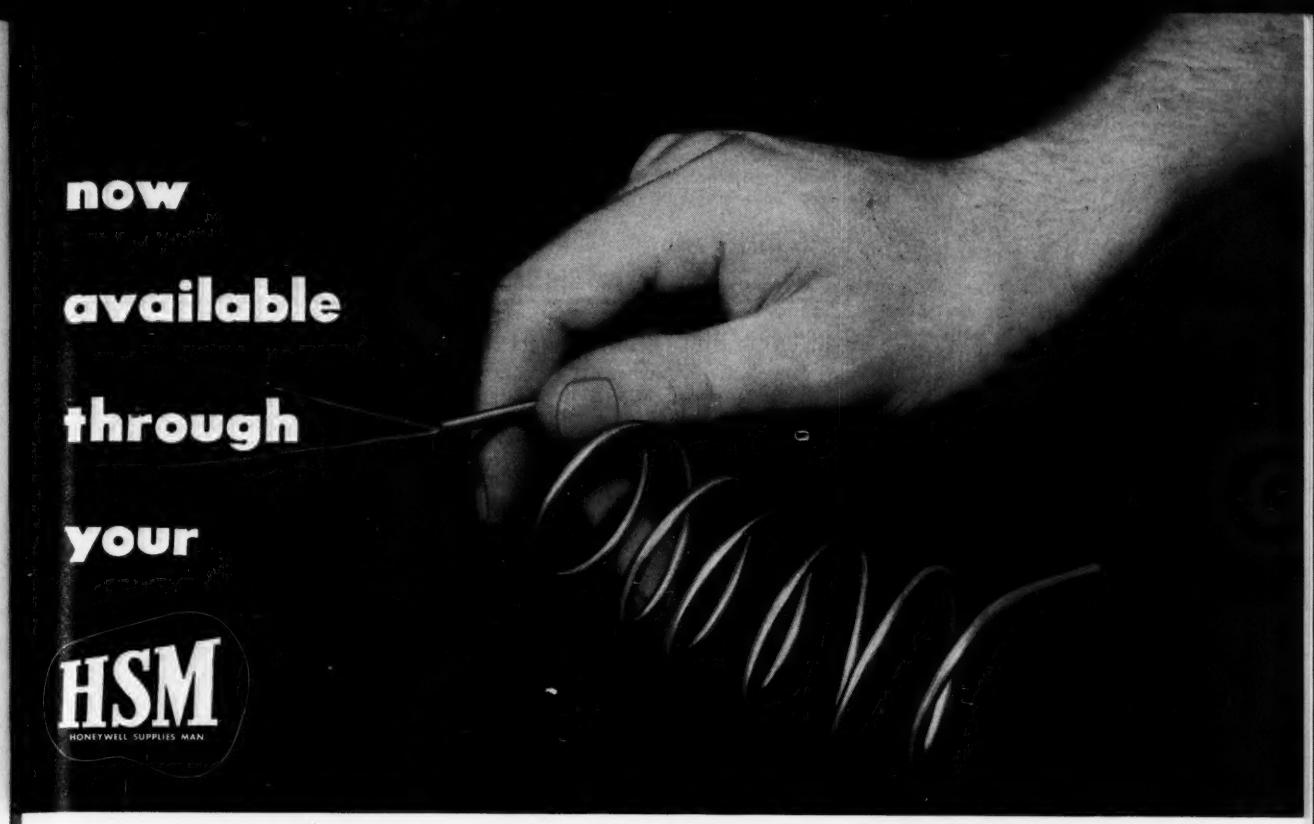


grip screw. Available in various lengths; blade widths of 3/16″, 9/64″, 0.102″, and blade thicknesses of 1/32″, 0.022″, and 0.014″ to handle from #0 to #¼ slotted screws.—*H. J. J. Co., 268 Marlowe Drive, Oakland 5, Calif.*

For more information circle **378** on inquiry card.

MAGNET CHARGER

New "Model 942" is a high-powered magnet charger capable of charging large Alnico and ceramic magnets, and other materials requiring large peak magnetizing forces. With its accessories, it can charge permanent magnets requiring up to 200,000 ampere-turns peak magnetizing force for



Honeywell's New MEGOPAK thermocouple wire small diameter . . . flexible . . . for use to 1400 F.*

DESIGNED originally for atomic energy projects, this ceramic-insulated packed type thermocouple wire is now available to industry. *MEGOPAK* wire is the latest development in small-diameter thermocouples, with emphasis on durability and high accuracy. It consists of two wires, surrounded by pure magnesium oxide insulation and encased in a metal sheath. This construction insures high accuracy and long life.

MEGOPAK wire is available in *Chromel Alumel*** and iron-constantan calibrations. Both can be supplied in either 1/16" or 1/8" diameter. The 1/8" wire is available with *Inconel* sheathing only, while the 1/16" wire is supplied with *Inconel* or 304 stainless steel.

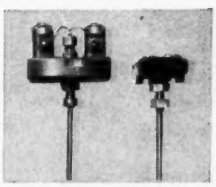
Lengths up to 25 feet have a minimum resistance of 2.5 megohms at 500 V dc at room temperature, when checked wire to wire or wire to sheath. The wire is flexible enough to be bent around twice its diameter . . . versatile enough to serve in a broad range of applications . . . rugged enough to withstand severe mechanical abuse. Accuracy meets the recommended tolerances of the Instrument Society of America.

MEGOPAK wire is one of the many special pyrometer supplies available with personalized service from your HSM (Honeywell Supplies Man). For complete details, call the HSM at your nearby Honeywell branch . . . as near as your phone. Or write for Specification S001-4.

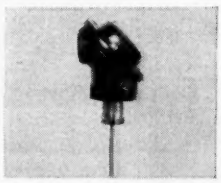
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Penna.—in Canada, Toronto 17, Ontario.

ORDER *MEGOPAK* WIRE OR ASSEMBLIES

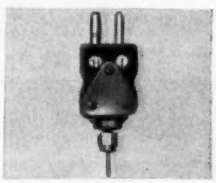
MEGOPAK *wire is available in standard lengths from 6 to 25 feet in 6-inch increments.*



Assemblies with terminal blocks are used for replacement units or where a terminal head can't be supported.



Assembly with terminal blocks and head. It's ready to use, with attachment of extension wires.



Assembly with quick-connect plug that need only be inserted in jack for use.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

**Trademark Minneapolis-Honeywell Regulator Co.*
***Trademark registered, Hoskins Manufacturing Co.*

For more information circle **127** on inquiry card.

NEW PLANT

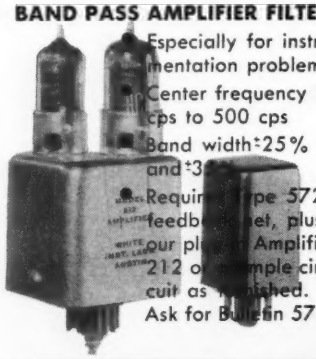
Our new plant at 5500 Balcones Trail, with expanded engineering and production facilities, will allow us to maintain prompt delivery of special networks and filters, in small or large quantities.

MORE PRODUCTION

- RC twin-T networks (Bulletin 500)
- Plug-in feedback nets (Bulletin 572)
- Plug-in amplifiers (Bulletin 212)
- Special LC filters

NEW PRODUCT

BAND PASS AMPLIFIER FILTER



Especially for instrumentation problems
Center frequency 2 cps to 500 cps
Band width ±25% and ±3
Requires type 572 feedback net, plus our plug-in Amplifier 212 or simple circuit as furnished.
Ask for Bulletin 572

NEW ENGINEERING

New Miniaturizations of RC filters and networks.

New active filter networks

AT A NEW ADDRESS

White

INSTRUMENT LABORATORIES
PO Box 9006
AUSTIN 17, TEXAS

For more information circle **128** on inquiry card.

NEW INSTRUMENTS

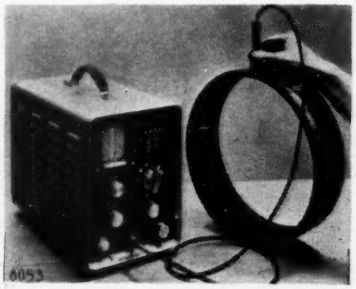
saturation. Energy stored in capacitor bank is discharged through an ignitron in a single unidirectional pulse into a pulse transformer and magnetizing adapter.—*Radio Frequency Laboratories, Inc., Powerville Road, Boonton, N. J.*

For more information circle **379** on inquiry card.

DIMENSIONAL GAGING

ULTRASONIC THICKNESS GAGE

New "SO-100 Sonizon" is said to "reverse present ultrasonic design

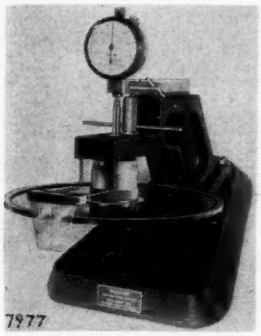


trends to either big, console-type equipment with visual presentation or to very small portable equipment with audible presentation." It is suitable for heavy-duty production testing; can automatically actuate "go-no go" equipment or alarms.—*Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.*

For more information circle **380** on inquiry card.

DIAL INDICATOR TESTER

New "Master" checks accuracy of all A.G.D. indicators; is said to replace gage-block method; utilizes an



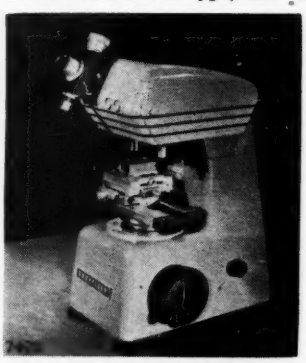
8" calibrated wheel with 0.0001" graduations and a hairline sight. Readings to 0.00002" can be easily estimated.—*Petz-Emery, Inc., Pleasant Valley, N. Y.*

For more information circle **381** on inquiry card.

MECHANICAL TESTING

MICRO-HARDNESS TESTER

New combination micro-hardness tester and metallurgical microscope, of non-destructive type, has load-



weight range of 25 to 1000 grams; requires only one minute for a complete test cycle; has interchangeable vise accessories.—*Sheffield Corp., 721 Springfield St., Dayton 1, Ohio.*

For more information circle **382** on inquiry card.

PORTABLE HARDNESS TESTER

Improved portable metal hardness tester provides direct readings in Rockwell "A", "B" or "C" scales or Brinell Medium or Low scales on practically any size, shape or type of

metal. Reading can be made in seconds by placing tester on metal, pressing handgrips down and reading dial. Tester comes complete with diamond penetrator and test block in wood case. "Bench Adaptor" is also available for continuous run testing.—*Newage Products, Inc., 222 York St., Jenkintown, Pa.*

For more information circle **383** on inquiry card.

ANGULAR ACCELEROMETER CALIBRATOR

New "Model AA C-2," for calibrating angular accelerometers within range of 0.5 to 140 radians per seconds squared (when typical instruments are mounted on oscillating table), is a torsional pendulum device which operates with low-decrement sinoidal oscillations. Both period and

THE

A B C

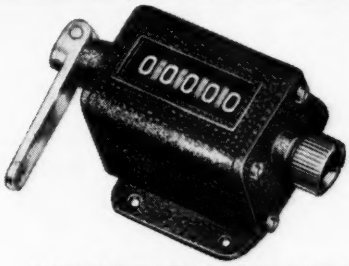
OF

1 2 3

Why is COUNTROL

important in every business today?

Countless times a day, every business needs to know "how many? . . . how much? . . . how far? . . ." and many other questions that can be answered only by facts-in-figures. But how to get these figures . . . from so many different machines, processes, operations and systems? Veeder-Root Counters are doing it every day, by means of:



MECHANICAL COUNTING

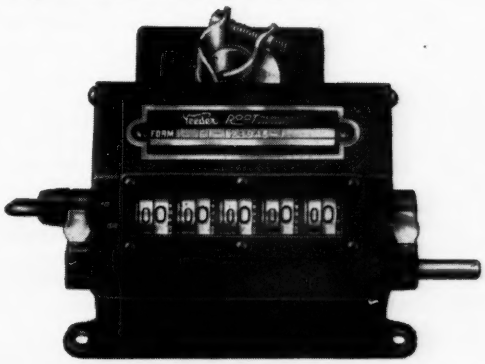
Small Resets count strokes, turns, or pieces . . . are used by thousands for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

HAND COUNTING

Where objects or units cannot be counted electrically or mechanically, hand-operated counters like this Hand Tally do the job. For instance, quick spot checks of production or performance, traffic count, inventory, etc. Fits palm of hand, counts one for each pressure of thumb lever, resets to zero by turning knob.

ELECTRICAL COUNTING

These remote-indicating counters bring your production machines as close as your office wall. AC or DC, they can be connected in series with any simple switch, and will transmit production figures *instantly* over any distance. May be panel-mounted in groups.



CONTROLLING

Set it for the exact number of turns, pieces, or operations required . . . and this Predetermining Counter will control the run *exactly* . . . preventing over-runs and shortages. When the predetermined number is reached, counter will light a light, ring a bell, or actuate a stop-motion.

IN SUM: *If it can be counted or controlled . . . count on Veeder-Root to do it. Get in touch with your Industrial Supply Distributor for standard counters for application to your production machines and processes. And get in touch with Veeder-Root for counters to be built into original equipment.* **Veeder-Root Inc., Hartford 2, Connecticut.**

Insist on Standard

VEEDER-ROOT COUNTERS

from your Industrial Supply Distributor

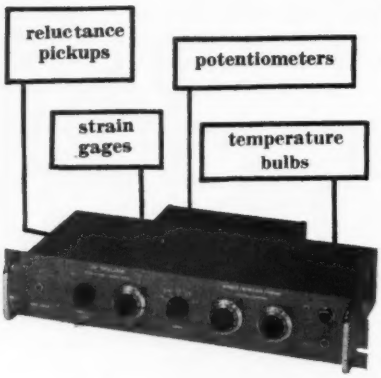
®

For more information circle **129** on inquiry card.

DO YOU HAVE A

PROBLEM

OF CONVERTING A PARAMETER TO FREQUENCY



wiancko

frequency modulated OSCILLATORS

These oscillators are designed to accept up to 24 Wiancko-type reluctance pickups, or several strain gages or potentiometers, and afford the maximum in reliability and repeatability. Operating on the phase-shift principle the instruments provide a linear frequency deviation proportional to input with compensation adjustments for non-linear pickups. Models such as the Type 18-1204 below are generally used in systems with bandwidths corresponding to real data. Other models are available using standard RDB bands. Controls on the front panel allow for adjustment of zero input frequency, bandwidth, and linearity. An additional DC analog output is provided so that data can be monitored on a meter, oscilloscope, and/or recording galvanometers.

SPECIFICATIONS, SERIES 18-1200

Power	+300 V, DC at 50 ma; −200 V, DC at 45 ma.
Bandwidth	2000 cps (10 KC to 12KC)*
Output	20 volts rms nominal.
Linearity	0.1% or better.
Temp. Range	0° to 160° F.
Zero Drift	Less than 1% of bandwidth for 100° F.

*Other models available with Std. RDB bands.

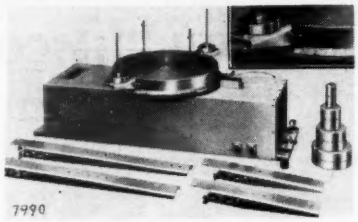
WIANCKO ENGINEERING CO.

255 NORTH HALSTEAD AVE.

PASADENA, CALIFORNIA

For more information circle **130** on inquiry card.

NEW INSTRUMENTS

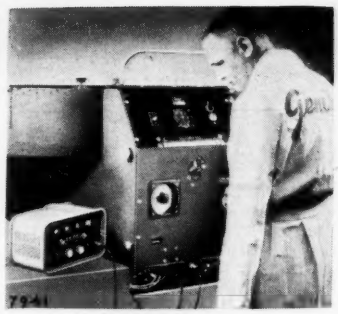


amplitude of oscillation can be set to obtain desired test conditions.—*Statham Development Corp.*, 12411 *W. Olympic Blvd., Los Angeles*, 64, *Calif.*

For more information circle **384** on inquiry card.

G-ACCELERATOR ACCESSORY

New accessory for accurately determining boom rotation speed of maker's "G-Accelerators, Models B78, C159 and D184," comprises a toothed wheel and a magnetic pickoff which can be directly connected to an electronic counter with a set time base. Toothed wheel is connected to main shaft of "G-Accelerator," produces 600 pulses per revolution.—*Genisco Inc.*, 2233 *Federal Ave., Los Angeles* 64, *Calif.*



For more information circle **335** on inquiry card.

ELECTRICAL TESTING

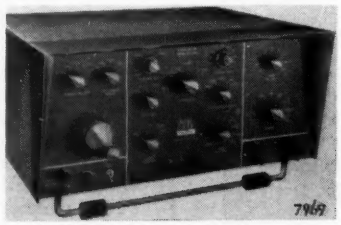
TRANSISTOR TESTER

New battery-powered "Model 505," for rapidly and conveniently determining important parameters of *p-n-p* and *n-p-n* small-signal medium-power and switching transistors, permits multiple testing of transistors operating in common-emitter configuration. —*Measurements Corp., Boonton, N. J.*

For more information circle **386** on inquiry card.

TRANSISTOR TESTER

New "Model BCT 300 Transistor Curve Tracer" is flexible and permits testing on all types in forward or reverse direction; plots entire family of curves on standard lab dc scope. Both 'scope axes can be accurately calibrated by use of internal standard which supplies a grid.—*Norden-Ketay Corp., 99 Park Ave., New York, N. Y.*



For more information circle **387** on inquiry card.

TRANSISTOR OSCILLATOR

New "Model J" 1000-cps transistor oscillator is self-contained and its battery operating life exceeds 700 hr. It provides pure sine-wave output voltages of 0, −13, −16 dbm at 1000 cps into 600-ohm line.—*Stewart Bros. Div., Instrument Labs.*, 315 *W. Walton Pl., Chicago* 10, *Ill.*

For more information circle **388** on inquiry card.

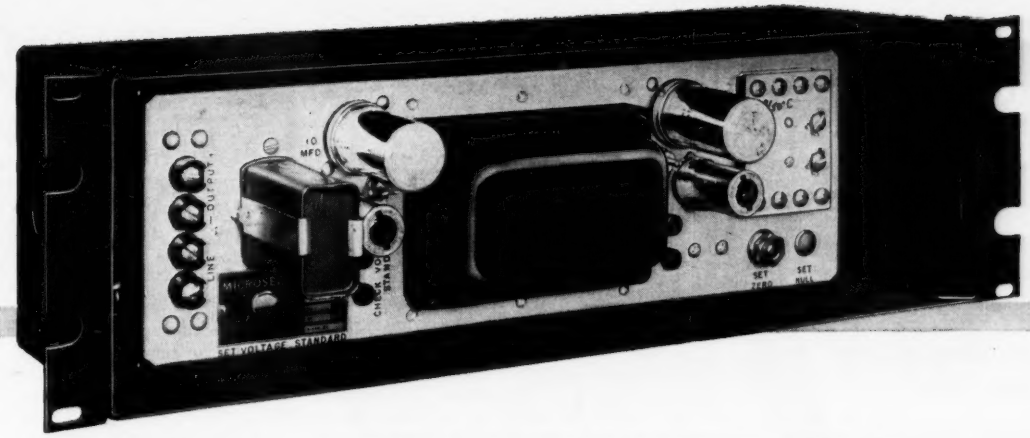
RESISTANCE BRIDGE

New "Model 605" wide-range direct-reading bridge rapidly and easily checks resistances over seven ranges from 100 ohms to 100 megohms full scale selectable by push button switches. Lowest measurable resistance is 5 ohms.—*Shasta Div., Beckman Instruments, Inc., P. O. Box* 296, *Station A, Richmond, Calif.*

For more information circle **389** on inquiry card.

SYSTEM TESTER

New "TM-1 Test Meter," for use with maker's "Centralized Operations Control System," permits fast simple testing without need of technically trained personnel. Special clips hold it in place on rack-mounted "COC" equipment. Attachment cable (inte-



NEW TRANSMITTING POTENTIOMETER OFFERS 7 BIG FEATURES

★ **Extreme sensitivity. Responds to input change of 3 microvolts or less.**

★ **Self-contained continuous voltage reference. No standard cells.**

★ **No batteries or periodic standardization. Continuous accuracy without drift.**

★ **Simple circuitry. Only 2 single triode tubes.**

★ **Interchangeable range card. Ranges easily changed in the field.**

★ **No slide wires or choppers. Trouble-free operation.**

★ **Fast response: 0.04 second time-constant for 1000° F. span.**

The Series 184 Transmitting Potentiometer is the latest addition to the 'American-Microsen' System of Electronic Transmission and Process Control. With this new unit, it is now possible to measure and control thermocouple temperatures or the signals from such devices as pH amplifiers, gas analyzers, resistance thermometer elements, and other electrical systems.

The extreme sensitivity of the new Potentiometer, plus the high resolution and response speed of the 'American-Microsen' Control System, makes it possible to control process temperatures with the high accuracy required by present-day production demands.

The 0.5 to 5.0 ma. signal output can be transmitted 30 miles or more, over a single 2-wire circuit. In addition to 'American-Microsen' receiver, the signal will operate standard d-c milliammeter indicators and recorders.

OPERATING SPECIFICATIONS

Spans: 6 to 50 millivolts d-c.
Suppression: Up to 5 times span.
Output Signal: 0.5 to 5.0 ma. d-c.
Sensitivity: 0.003 millivolts (0.1° F.).
Repeatability: 0.02 millivolts. (0.6° F.).
Input Source Impedance: 200 ohms maximum.
Effective Input Impedance: 1000 ohms per millivolt of span.
Output Load Impedance: 3000 ohms maximum.
Speed of Response: 0.8 seconds for 99% response on 6 millivolt span. Speed increases with span.

Write today for Bulletin MTT810.

MANNING, MAXWELL & MOORE, INC.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

INDUSTRIAL CONTROLS DIVISION, STRATFORD, CONNECTICUT

MAKERS OF THE 'AMERICAN-MICROSEN' TRANSMISSION AND PROCESS CONTROL SYSTEM, 'AMERICAN-MICROSEN' ELECTRO-PNEUMATIC TRANSDUCERS AND ELECTRO-HYDRAULIC CONTROL VALVE OPERATORS.

For more information circle **131** on inquiry card.

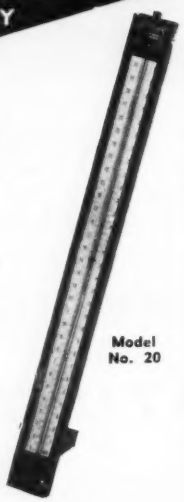
Trimount

MANOMETERS

- EASY READING
- ACCURATE
- STURDY

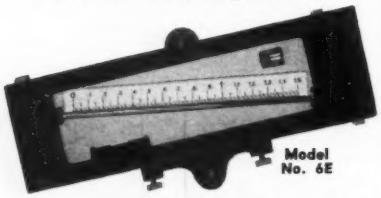
WELL TYPE MANOMETERS

- Welded steel channel
- Enclosed plate glass cover
- Red Line Pyrex tube
- Front Zero adjustment



Model No. 20

DRAFT GAUGES
with Wall Mounting Brackets



Model No. 6E

- Dust tight glass cover
- Adjustable scale
- Pyrex tube—compression gland packed

Model No. 4

SLIDING SCALE U-TUBE MANOMETERS

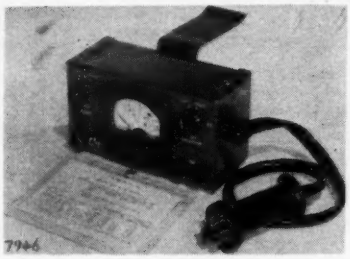
- Cast aluminum channel
- Heavy Pyrex U tubes
- Leak proof compression type glands

Write for latest bulletin E showing our complete line of Manometers. Contact us for custom made designs to help you solve your problems.

Trimount INSTRUMENT CO.
3111 WEST LAKE STREET • CHICAGO 12, ILLINOIS

For more information circle **132** on inquiry card.

NEW INSTRUMENTS



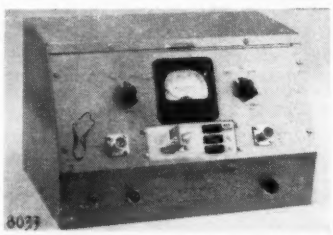
7946

gral part) has plug-in connector that mates with sockets provided in every unit of "COC" equipment. All tests can be conducted without changing test leads or interrupting service.—*Hammarlund Mfg. Co., Inc.*, 460 *W. 34th St., New York* 1, *N. Y.*

For more information circle **390** on inquiry card.

DIODE TESTER

New "Model ND-1 Standard Diode Pulse Recovery Test Set," for measuring the inverse pulse recovery of



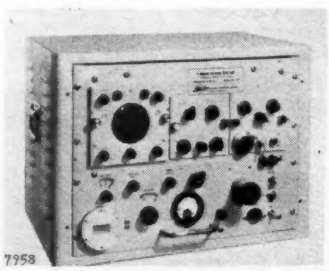
8033

silicon and germanium diodes, has been accepted as the standard test method of JETEC of RETNA Committee on Solid State Devices. Feature: inherently low load time constant, which allows recovery time of test set itself to be much lower than that of most available diodes.—*Hauman Instruments Company, Inc.*, 70 *Coolidge Hill Road, Watertown* 72, *Mass.*

For more information circle **391** on inquiry card.

RADAR TEST SET

New Radar Test Set, for complete check-out of radar and other microwave transmitters in field or on pro-

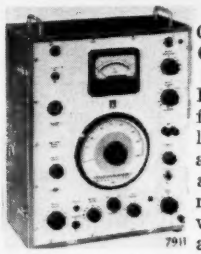


7958

duction line, is available in C-band, X-band and Ku-band frequencies; includes spectrum analyzer, power monitor, direct-reading frequency meter, signal generators with variable pulse, sawtooth and square-wave modulation.—*Kearfott Co., Inc., Western Div.*, 253 *N. Vinedo Ave., Pasadena, Calif.*

For more information circle **392** on inquiry card.

SIGNAL GENERATOR



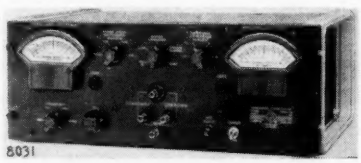
7911

New "Signal Generator and Control System" (mfd by Bruel & Kjaer) is a beat-frequency oscillator designed for a wide range of audiofrequency measurements, with facilities for automatic frequency scanning and chart recording of data as when used with "Brush High Speed Level Recorder Model BL-2304." Logarithmic frequency range, 20 to 20,000 cps, can be swept continuously manually or by external drive. Other unique features include remote control facilities, an output control system to permit external signal feedback, and automatic frequency markers.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **393** on inquiry card.

IMPEDANCE COMPARATOR

New high-precision "Model 1605-A" facilitates rapid sorting of electrical components; indicates directly the



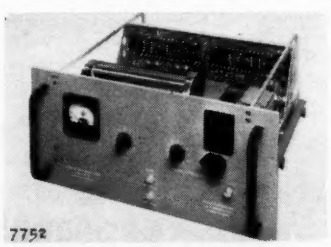
8031

percent difference between two impedances without requiring a bridge balance; can be used to compare complex impedances of any phase angle; also indicates simultaneously the phase-angle difference. On sensitive ranges, differences can be determined to 0.01% and to 0.0001 radian, respectively.—*General Radio Co.*, 275 *Massachusetts Ave., Cambridge* 39, *Mass.*

For more information circle **394** on inquiry card.

1-Mc SIGNAL SOURCE

New "Ultra Stable Oscillator," for use as a secondary frequency standard, etc., delivers 1 Mc tunable over



7752

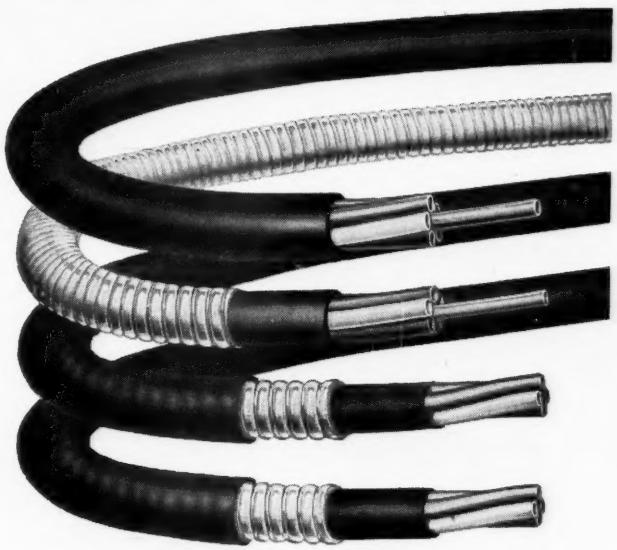
a range of ±0.5 cps, with drift less than 1 part in 10^9 per day after one month's operation. Crystal oven temperature stabilized to better than 0.01 C°. Outputs: sine wave 4 v rms; pulse 1 v; output impedance about 250 ohms.—*Hycon Eastern, Inc.*, 75 *Cambridge Parkway, Cambridge* 42, *Mass.*

For more information circle **395** on inquiry card.

The Answer To Your Corrosion Problems

CRESCENT ARMORED MULTITUBE

FOUR CORROSION-RESISTANT TYPES



TYPE CT—In damp or corrosive locations where a moderate degree of mechanical protection to the tubes is required, as in troughs or attached to sheltered building surfaces as supporting means, the first construction illustrated is recommended. It employs a tough, corrosion-resistant polyvinyl chloride thermoplastic sheath, resistant to water, acids, alkalies, oils and most chemicals, applied over CABLED copper* tubes. The sheath will not support combustion.

TYPE CTA—gives corrosion protection to the tube, and the galvanized steel armor protects the tubes and polyvinyl thermoplastic sheath from mechanical injury during and after installation. Recommended for direct burial in concrete or pulling into underground conduits.

TYPE CAT—gives corrosion protection to the galvanized steel armor as well as the tubing. Recommended where the polyvinyl thermoplastic sheath will not be subject to mechanical injury.

TYPE CTAT—Combining the advantages of Types CTA and CAT, the fourth type illustrated has the polyvinyl chloride thermoplastic sheath both under the armor and over the armor, thus providing maximum mechanical and corrosion protection.

**All these corrosion-resistant types can be furnished with other types of tubing, and up to* 19 *tubes.*

Plastic Coated Single Tubes, copper or aluminum should be used to give corrosion protection to all single lines up to the final tube fitting where trouble from corrosion may occur. Available as *CRESCENT Single tube* Type CT.

Send for Bulletin 356-A giving complete information and engineering data

CRESCENT INSULATED WIRE & CABLE CO.

TRENTON, NEW JERSEY

PRODUCTION ENGINEERS

JOIN THE LEADER IN AERO CONTROLS!

Honeywell needs top-notch Process Engineers at all levels of responsibility for directing the production of such *airborne* control systems as:

INERTIAL GUIDANCE
INLET AREA CONTROL
JET ENGINE CONTROL
FIRE CONTROL AND BOMBING
FLIGHT CONTROL SYSTEMS
FUEL MEASUREMENT AND MANAGEMENT
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Engineers selected will analyze designs, establish process methods and control, and guide designs toward economical and speedy production.

■ To qualify, you should be familiar with process evaluation, cost estimating, tool ordering, metals fabrication, and manufacturing-assembly operations. Your background should be in the area of *precision* electrical, mechanical, or hydraulic devices such as gyros, accelerometers, operational computers, pressure switches, amplifiers, calibrators, altitude compensators, and thermistor level switches.

■ These are permanent, career-building positions that Honeywell can offer because of its succession of achievements in airborne control systems, broad diversification, and healthy balance between civilian and military contracts.

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■ Minneapolis offers you metropolitan living with a suburban way of life . . . A city of beautiful lakes with every recreational facility a few minutes from your home.

■ Outstanding educational opportunities . . . Liberal tuition allowances paid by Honeywell.

■ Plant and technical facilities among the best in the industry.

■ Honeywell pays your family moving expenses.

■ Salaries, insurance-pension programs are all first rate.

■ Honeywell, the nation's leading supplier of control systems, manufactures over 10,000 diversified products. A sound growth company, Honeywell offers continuing expansion and permanent opportunities for you to advance.

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If you are interested in a career at Honeywell, call collect or send your résumé to Bruce Wood, Technical Director, Dept. T-9, Aeronautical Division, 1433 Stinson Boulevard, N.E., Minneapolis 13.

MINNEAPOLIS
Honeywell
AERONAUTICAL DIVISION

ELECTRICAL and ELECTRONIC INSTRUMENTS

DIGITAL DC RATIOMETER

New "R 105" measures ratio of two dc voltages, E_1 and E_2, where E_1 is derived from E_2 and E_2 drives both

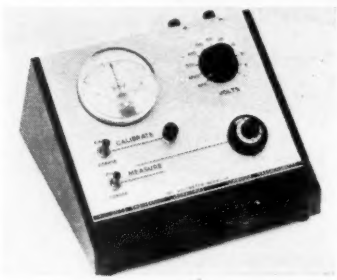
7928

ratiometer bridge and test unit. Range 00.000 - 99.999; maximal resolution 1 part in 100,000; average reading time 1 second. Optional: remote read-out and printer operation.—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego, Calif.*

For more information circle **396** on inquiry card.

POTENTIOMETER

New "Model VI" features accuracy better than 0.5%, simplicity and low cost; has ten overlapping ranges from



1 to 1000 v; is designed to fill gap between high-precision lab potentiometers and low-precision instruments; uses null-balance potentiometric method, 1½-v dry cell, and built-in standard cell for reference. *Nuclonics Engineering Labs., Inc.*, 32 *Monadnock Rd., Wellesley Hills* 81, *Mass.*

For more information circle **397** on inquiry card.

TWO-CHANNEL OSCILLOGRAPH

New "Type 5-301 Datagraph" and "Type 1-133" amplifier constitute a two-channel direct-writing oscillo-

7918

graph which instantaneously records frequencies as high as 250 cps at 1" double amplitude; is said to have "greater flexibility than any direct-writer on the market today"; can record voltages from practically any source. Rectilinear record can be seen immediately. Six chart speeds; automatic time pulses; manual "event marker."—*Consolidated Electrodynamics Corp.*, 300 *N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **398** on inquiry card.

EDGEWISE MICROAMMETER

New "Model 700" edgewise indicating instrument features full-scale sensitivity of ½ microampere, believed

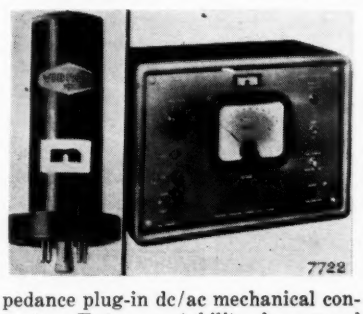
7945

to be unique in electrical measurements field; is the first of a series for voltage, current and resistance measurements, all with bifilar suspension movement which minimizes friction losses and prevents external-stress damage.—*Greibach Instruments Corp., Metuchen, N. J.*

For more information circle **399** on inquiry card.

ELECTROMETER SYSTEM

New "Vibron Electrometer" for measuring ionization currents, infrared signals, etc., is an ultrahigh-im-


7722

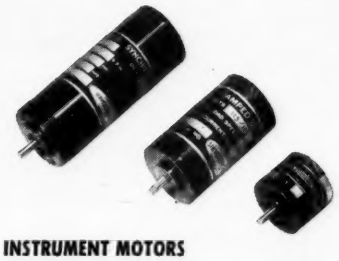
pedance plug-in dc/ac mechanical converter. Extreme stability is assured by sealing gold-plated electrodes in a gas-filled metal envelope. ★ Matching "Type 33B" dc amplifier, with input impedance of 10^{13} ohms, has six ranges covering 10 to 1,000 mv with a stability of better than 0.1 mv over a 12-hour period.—*Central Electronics Mfrs., Inc., Sub. Nuclear Corp. of America, Inc., Suite* 4219, *Empire State Building, New York* 1, *N. Y.*

For more information circle **400** on inquiry card.

MICROVOLT-AMMETER

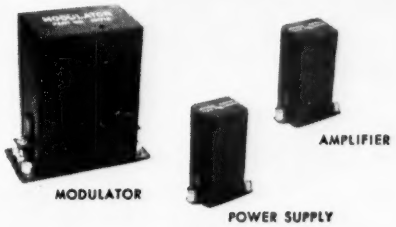
New "Model 203R" ultrasensitive rack-mountable dc microvolt-ammeter and amplifier permits accurate measurements from 10 uua to 100 ma and from 10 uv to 1000 v; can also be used

SAVE VALUABLE DESIGN TIME
in both development and production by using SERVOMECHANISMS' proven components.

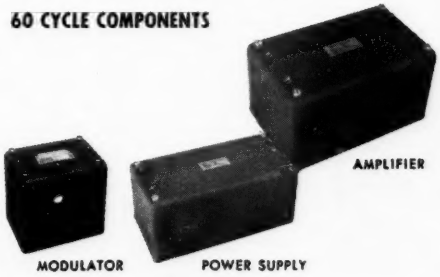


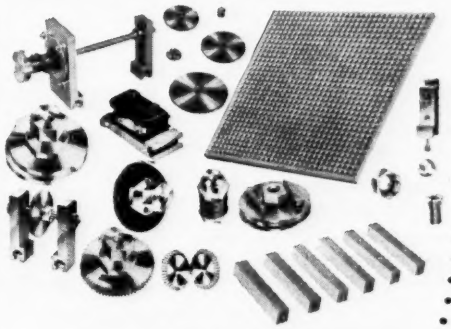
INSTRUMENT MOTORS

400 CYCLE COMPONENTS



60 CYCLE COMPONENTS





MECHANICAL DEVELOPMENT APPARATUS

These proven components *are available now.* We've designed them—allowing you to concentrate your time on the application. The 60 and 400 cycle components, together with the companion instrument motors and the extensive line of Mechanical Development Apparatus, offer the Design Engineer an assortment of ready-made units that are ideally suited for closed loop control applications.

These packaged function components are plug-in units permitting quick and easy replacement *anywhere.*

Servomechanisms, Inc. manufactures these units for use in its own analog computers and control systems. *Now,* they are available as individual units. All of the components meet applicable military specifications for both prototype and production deliveries.

The design philosophy of packaged functions; the years of manufacturing experience, and the constant improvement of the basic units, all add up to optimum adaptability, performance and reliability.

Find out more about these quality units and how they can Save You Design Time. Write today for complete technical information.

SERVOmechaNISMS INC. EA-356

MECHATROL DIVISION, 625 Main Street, Westbury, L.I., New York

For more information circle **134** on inquiry card.

Never Before

Such A Versatile, Low Cost ALARM SYSTEM!

SCAM DU-ALL
(Patent 2,730,704)

Scam Model SC-10 DU-ALL annunciator systems introduce new standards for compactness, usefulness and economy. Available in four standard cabinet sizes with Scam's unique plug-in relays, plug-in light boxes with 2-section back lighted nameplates. Each plug-in and light box combination provides alarm indication for two separate and unrelated field conditions . . . Write or phone for information on your specific alarm problem.

ALARM SEQUENCE:

Normal: lights off, horn off
Abnormal: lights flashing, horn on
Reset: lights bright, horn off
Normal again: lights off, horn off

Features of the SC-10 MODEL

1. **Interchangeable with standard Scam systems.**
2. **Operates with normally open field signals.**
3. **Optional Lock-in of momentary alarms.**
4. **De-energized circuit (no-drain).**
5. **Photograph illustration above with 20 alarm stations requires panel area of only 7⅜" high x 17⅜" wide.**
6. **Two lamps for each indication.**
7. **Economical.**

THE SCAM INSTRUMENT CORP.

Chicago 18, Illinois
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For more information circle **135** on inquiry card.

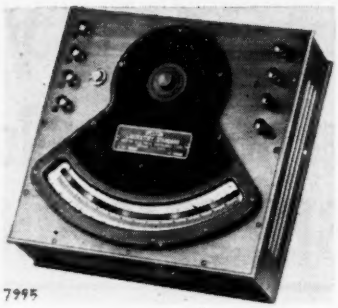
NEW INSTRUMENTS

as a low-drift dc amplifier with 80 db gain and high input impedance. Circuit: input divider followed by a chopper amplifier and a two-stage direct-coupled meter-driver amplifier. High input impedance and stability assured by unique feedback arrangement which provides up to 84 db of over-all feedback. New instrument is useful as a recorder driver where recorder does not have required high input impedance or sensitivity.—*Kay Lab, 5725 Kearney Villa Road, San Diego 11, Calif.*

For more information circle **401** on inquiry card.

SELF-SHIELDED STANDARD

New "Model 325 D-C Laboratory Standard" replaces "Model 5"; is claimed to have a far greater degree of shielding than any previous instrument in 0.1% accuracy class: no measurable error in a 5-oersted field; no need to position instrument with relation to earth's magnetic field, nor to take special precautions in presence of current-carrying conductors.—*Weston Electrical Instrument Corp., Newark 5, N. J.*

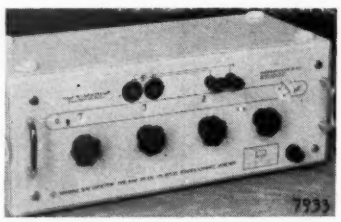


For more information circle **402** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

STANDARD CAPACITOR

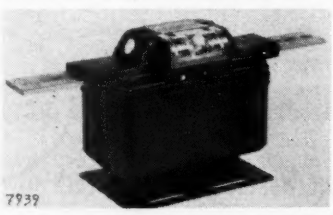
New "Type FT-KGM" precision decade three-terminal standard capacitor, whose accuracy of 0.2% is said to exceed by far that of previously available commercial test capacitors, can serve as a lab standard, for calibration, for various circuit measurements, etc. Its three terminals permit it to be used as a grounded or ungrounded component. Owing to its high resonant frequency (about 0.35 to 11 Mc) it is useful over a wide frequency range. Total capacitance range extends from 100 uuf to 1.11 uf. Settings are made on three decade scales and one continuously-variable air capacitor scale.—*Federal Telephone & Radio Co., Instrument Div., 100 Kingsland Rd., Clifton, N. J.*



For more information circle **403** on inquiry card.

CURRENT TRANSFORMER

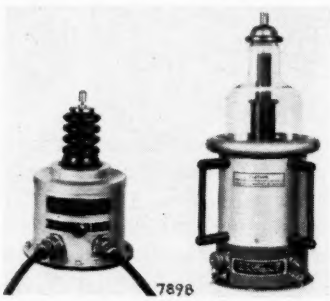
New "JKM-4" butyl-molded 8700-v indoor current transformer for operating instruments, meters, relays, and control devices, is available in all standard single-primary current ratings from 10 to 800 amp and all ratings have a single 5-amp secondary. Frequency rating 25- to 60-cps. Meter accuracy is ASA Class 0.3 with burdens B-0.1 to B-2.0. ASA relay accuracy class is 2.5H100 at 60 cycles.—*General Electric Co., Schenectady 5, N. Y.*



For more information circle **404** on inquiry card.

HV CAPACITANCE DIVIDERS

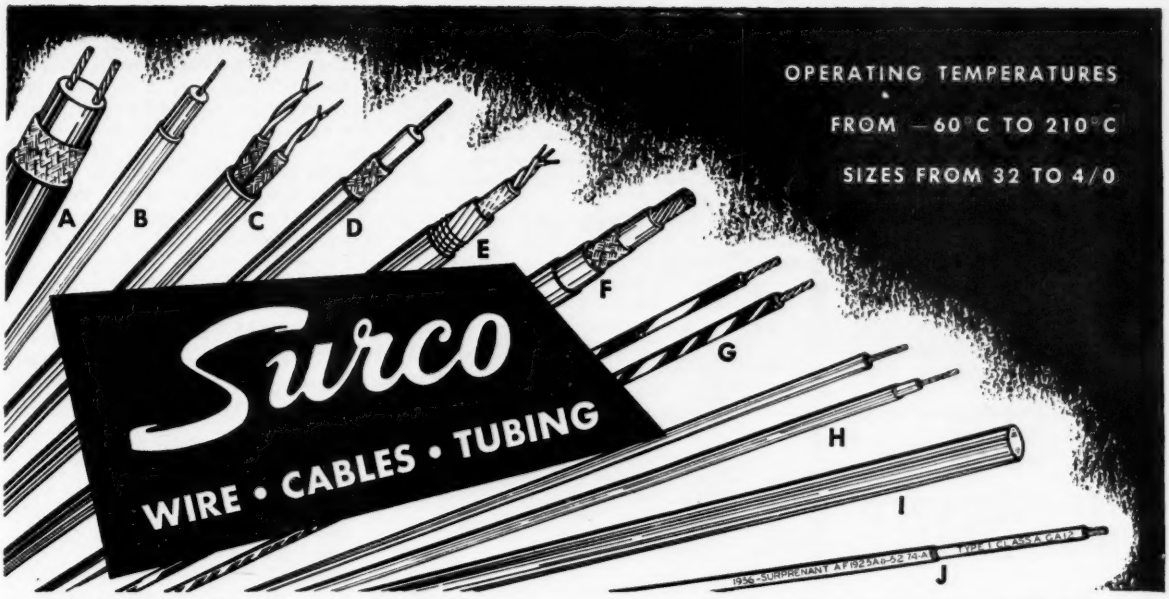
Two new high-voltage capacitance voltage dividers can be used with almost any synchroscope or CRO. "Model VD-35" has a 35,000-v peak and division ratios of 200 to 1 and 50 to 1. "Model VD-100" incorporates a vacuum capacitor, is highly stable, has extremely wide voltage range (250 to 100,000 peak) and division ratios of 500 to 1, 100 to 1, and 10 to 1.—Manufactured by Press Wireless Laboratories, Inc., and distributed by *Vectron, Inc., 1571 Trapelo Road, Waltham 54, Mass.*



For more information circle **405** on inquiry card.

CUSTOMIZED TRANSFORMERS

New line of customized small transformers features universal-type mounting, low-cost reliable terminal construction, aluminum casing; rub-



A **Coaxial Cables** — "Surco" coaxial cables include a wide variety of types, such as low capacity, extra flexibility, small diameter, microphone 2 conductor, and high temperature "Teflon". Conform to Military Spec. MIL-C-17B. Many special designs. If you have a coaxial cable problem consult us.

B **"Miniature Coaxial Cables** — Extruded low-loss Teflon dielectric O. D. under 1/16 inch for 50 ohm cable and under 1/8 inch for 95 ohm cable. Low capacitance, stable electrical characteristics."

C **Miniature Wire and Cable** — "Surco" miniature wire and cables are made in conductor sizes down to No. 32 AWG in stranded and No. 30 AWG in solid. Close control in manufacturing permits small finished diameters on both single and multi-conductor cable. Available in standard colors with and without nylon jackets or shielding in the various vinyl or polyethylene compounds.

D **"Surflene" Insulated Hook-up Wire and Tubing** — "Surflene", extruded monochlorotrifluroethylene, has excellent resistance to heat, abrasion and most chemicals, including nitric acid. Having high dielectric strength and insulation resistance, it is especially useful in totally enclosed applications with continuous temperatures up to 135°C. "Surflene" is available in 15 solid colors and wall thickness down to 0.008". Also available in limited range of sizes in transparent or colored tubing.

E **Multi-Conductor Cables** — "Surprenant" Multi-conductor cables are available with conductor sizes from No. 32 AWG and larger with vinyl, "Surflene", or Teflon insulation, with or without nylon jacket or shielding and can be made to specification for special design and applications. Close tolerances permit unusually small overall diameters and "Spiralon" color coding permits easy identification even when hundreds of conductors are involved.

F **New Improved Aircraft Wire** — Surprenant new lightweight, smaller diameter MD wire (vinyl, glass braid, nylon) and the standard Surprenant sandwich construction (Vinyl, glass braid, nylon) give excellent overload safety, high and low temperature performance, good electrical properties and have a nylon jacket giving greater resistance to abrasion, fungus, moisture, hydraulic and other oils (nylon braided jacket on size 10 AWG and larger for greater flexibility) and are made to conform to MIL-W-5086. "Surprenant" also offers nylon jacketed polyvinylchloride construction made to conform to Military Spec. MIL-W-5086, MIL-C-7078, and MIL-W-7072.

G **"Spiralon"** — "Surco-Spiralon" color coding is available on all vinyl, nylon, Teflon, and Kel-f insulated wires, with or without nylon jackets. One, two or three color stripes are available in the Nema colors providing almost unlimited color identifications. Solid color insulation is also available in the 10 standard Nema colors.

H **"Surco" A-10 for (105°C) Hook-up Wire** — A-10 is an unusually high grade vinyl insulating compound developed in our own laboratories for a better hook-up wire. It has excellent resistance to deformation, soldering, high temperature, low temperature and aging; high electrical properties; Underwriters Lab. approved for continuous operation to 105°C without fibrous covering. A-10 insulated wire made to conform to MIL-W-16878B, Types B, C, and D, with or without nylon jackets or synthetic braids.

I **"Surco" Tubing** — "Surco" vinyl, nylon, polyethylene, silicone rubber, Kel-f and Teflon tubing available in a wide variety of sizes, temperature ranges, electrical and physical characteristics.

J **MIL-W-5274A Radar & Electronic Hook-up Wire** — Made to conform to Air Forces Spec., this wire offers excellent low temperature performance. Nylon jacketed, is has high abrasion resistance and superior surface resistivity even under adverse humidity conditions, making it very adaptable for high impedance circuits.

Silicone Rubber Wire and Cable.— Thin wall silicone wire for 600 and 1000 volt service up to 400°F continuously and higher with short life ratings. Remains flexible at—100°F. Braided and jacketed constructions available for increased mechanical and abrasive characteristics.

Extruded THIN WALL Teflon INSULATED (210°C) HOOK-UP WIRE

Continuously operable over the range from —90°C to 210°C without appreciable deterioration, extruded "Teflon" (polytetrafluoroethylene) is now available in walls as thin as 0.010" (type WTE) and 0.015" (type RTE). Teflon combines non-flammability, chemical and solvent resistance, high volume and surface resistivity with extremely low electrical losses. This wire is available in all flexible strandings from AWG 8 and conforms to performance requirements of MIL-W-16878B. Colors and Spiralon markings conform to MIL-STD-104. Also, available in limited range of sizes in natural or colored tubing.

Surprenant MFG. CO.

CLINTON, MASS.

See us at Booth 350 at the Third International Automation Show.

For more information circle **136** on inquiry card.

DESIGNERS

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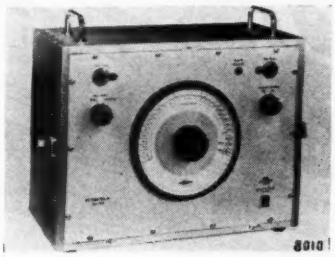
NEW INSTRUMENTS

ber-covered leads; and multi-range regulator design ballast with primary voltages from 100 to 520.—*Outdoor Lighting Dep't, General Electric Co., Hendersonville, N. C.*

For more information circle **406** on inquiry card.

FILTER SET

New "Model BL-1609 One-Third Octave Filter Set" (mfd by Bruel & Kjaer) designed for sound and vibra-



tion measurements and, in general, any audio signal analysis or telemetry data reduction, comprises 27 flat-topped filters of 1/3 octave band pass width with seven additional filters available as optional equipment to cover 14-36,000 cps spectrum; also standardized weighting networks and a linear band pass.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **407** on inquiry card.

FLAT-FACE 'SCOPE TUBE

New "1EP1" flat-face oscilloscope tube, 1¼" diameter, is intended primarily for use in light-weight portable equipment or in continuous monitoring service for large equipment. Useful screen diameter 1⅛"; over-all length 4⅛"; weight 2 oz; medium-persistence P1 Phosphor.—*Radio Corp. of America*, 30 *Rockefeller Plaza, New York* 20, *N. Y.*

For more information circle **408** on inquiry card.

ANALOG FILTERS

New series of analog filters for sharp bandpass performance at audio and subsonic frequencies is announced.

"Model BP-160" features independent control of HF and LF band limits; cut-off at rate of 166 db per octave in each case; voltage-frequency characteristic an exact analog of a multi-section passive *LC* filter. Analog achieved without inductances, hence no conventional LF design limitations. —*Spectrum Instruments, Inc.*, 44-05 30*th Ave., Long Island City, N. Y.*

For more information circle **409** on inquiry card.

POWER SUPPLIES, AMPLIFIERS, etc.

OSCILLOGRAPH SUPPLY

New "Type 3-131" dc power supply, designed for oscillograph operation but usable in many other applica-

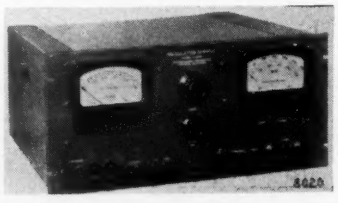
tions, provides 23.5 to 28.5 vdc at 16 amp max.—*Consolidated Electrodynamics Corp.*, 300 *North Sierra Madre Villa, Pasadena, Calif.*

For more information circle **410** on inquiry card.

FAST-RESPONSE DC SUPPLY

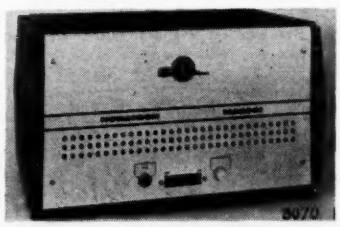
New "Model 3-1.5 MB" is a 1½-amp unit featuring fast recovery time: 0.4 millisecond no-load to full load and 0.25 ms FL to NL, enabling use with computers and quick-response lab and industrial applications. It delivers 0 to 300 vdc continuously variable without switching; variable bias voltage of 0-145/155 @ 5 ma., and 6.3 vac @ 10 amp.—*Dressen-Barnes Corp.*, 250 *N. Vinedo Ave., Pasadena, Calif.*

For more information circle **411** on inquiry card.



TUBELESS DC SUPPLY

New "Model MA 6501" delivers 6 vdc and 2 vdc (40, 60 and 100 ma loads) regulated to within 0.01% and



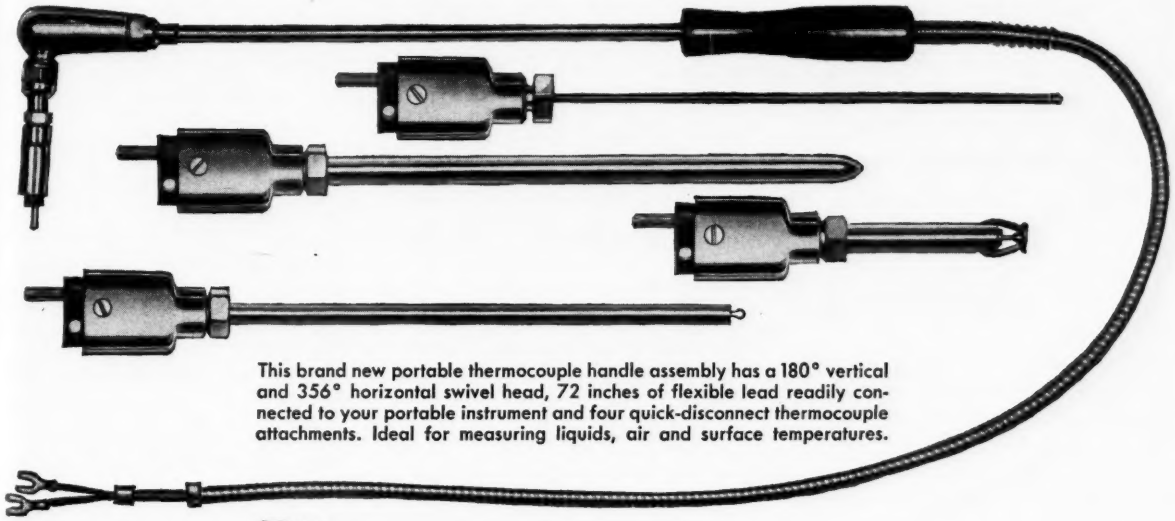
also 6 vdc (5% adjustable) for a 5-amp load; features a rugged-construction transistorized circuit combining reliability and precise performance. A silicon diode is used as reference element, and a temperature-compensated transistor amplifier provides control current for magnetic ampli-

For FASTER...EASIER...MORE ACCURATE ANSWERS

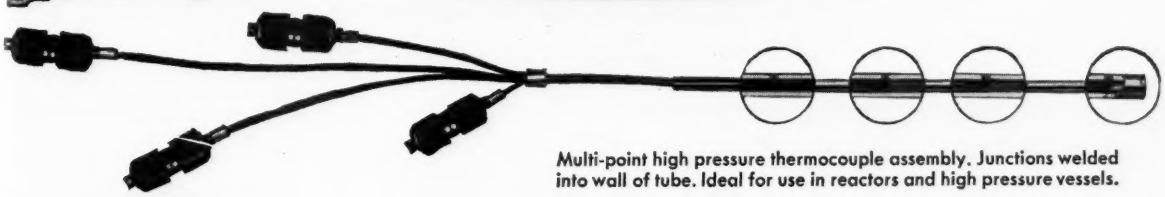
to all kinds of temperature measuring problems!

NEW CONCEPTS IN MINIATURE THERMOCOUPLE ASSEMBLIES!

Here are just a few of the many new types of thermocouple assemblies that are shown and described in detail in our new catalog. All are ingeniously designed in miniature sizes for your greater convenience . . . engineered for greater adaptability. All are available in Iron-Constantan, Copper-Constantan, and Chromel-Alumel. Send for complete catalog!



This brand new portable thermocouple handle assembly has a 180° vertical and 356° horizontal swivel head, 72 inches of flexible lead readily connected to your portable instrument and four quick-disconnect thermocouple attachments. Ideal for measuring liquids, air and surface temperatures.

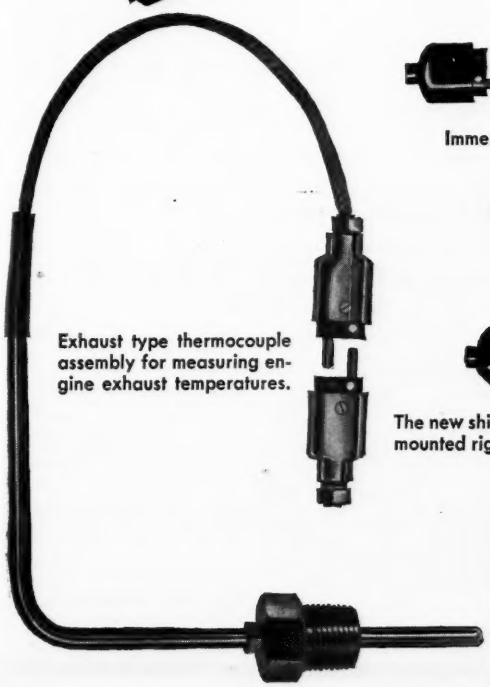


Multi-point high pressure thermocouple assembly. Junctions welded into wall of tube. Ideal for use in reactors and high pressure vessels.

Immersion type thermocouple assembly for measuring liquid temperatures.

Bolt type thermocouple assembly. Exposed junction for fast response. Best for measuring bearing and block temperatures.

The new shielded thermocouple assembly with a quick-disconnect connector mounted rigidly to the tube. Designed for measuring gas flow temperatures.



Exhaust type thermocouple assembly for measuring engine exhaust temperatures.

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For more information circle **137** on inquiry card.

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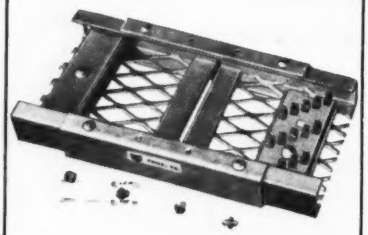
for Supporting Instrument Tubing



P-W Manufactures a complete trough system with channel connectors. Drive rivets are used for quick assembly.—Extension Connectors eliminate field cutting—Adjustable connectors for any change in direction or elevation—I Section for long spans—Tube Clips—Cushion Clamps

Raceway to support a limited number of tubes with connectors, elbows, tees, etc.—Bulkhead Bar. P-W systems are available in widths from 1" to 24" and in lengths from 1' to 16'.

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Duncan & Melrose Sts.,
Philadelphia 24, Pa.

(Representatives to serve you!)

For more information circle **138** on inquiry card.

NEW INSTRUMENTS

fier. Typical stability after a 30-minute warm-up is 0.01% for an 8-hr period.—*Sorensen & Co. Inc., Fairfield Ave., Stamford, Conn.*

For more information circle **412** on inquiry card.

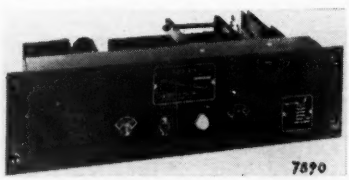
REGULATED POWER SUPPLIES

New "Z-95000 Series" power supplies are unique in plug-in circuit design with no components mounted under chassis. Output voltage variable from 175 to 250 vdc at 200 ma (either plus or minus can be grounded). Regulation better than 1% from 0 to 130% of rated load. Total ripple and noise less than 7.2 mv rms. Available: filament voltage 6.3v 8 amp, and 0-150-v bias supply. Bench and rack-mounted models available. One rack-mounted model has an integral blank chassis for building counters, timers, divider systems, pulse generators, etc. with maker's plug-ins.—*Eeco Production Co., 506 E. First St., Santa Ana, Calif.*

For more information circle **413** on inquiry card.

REGULATED DC SUPPLY

New improved "Model MA65A" tubeless regulated dc source, utilizing magnetic amplifier circuitry, is



recommended for unattended installations. Input range 105-125 vac, 1 phase, 60 cycle; output voltage 5.4 to 6.6 vdc, adjustable; load range 0-5 amp; ripple 1% maximum; regulation accuracy 0.2% against line or load (1/10 to full); recovery time 0.15 sec.—*Sorensen & Company, Inc., Fairfield Avenue, Stamford, Conn.*

For more information circle **414** on inquiry card.

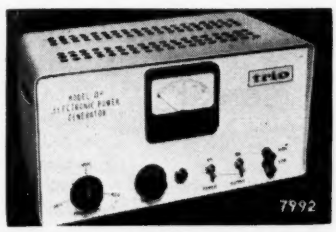
POWER SUPPLY AND DEMODULATOR UNIT

New "Model DV-1 Regulated Power Supply—Demodulator Unit," for use with gyros in flight test applications where 115-v 400-cps single-phase primary power is available, weighs 13 lb; has been designed for use with 1 to 3 Doelcam "Model K Rate Measuring Gyroscopes" to comprise a complete rate measuring system. It energizes motor and pickoff of each gyro and converts ac outputs to dc for oscillograph galvanometers. —*Doelcam Div. Minneapolis-Honeywell, 1400 Soldiers Field Road, Boston 35, Mass.*

For more information circle **415** on inquiry card.

ELECTRONIC POWER SUPPLIES

New "Model DP Electronic Power Generators" deliver up to 100 va of low-distortion power. Four standard



models (400, 1000, 1600, and 2000 cps) are available in two versions: single, factory-set frequency, or variable frequency, panel-controlled over a range of ±5% of nominal. Any non-standard output frequency can be specified, and tuning fork-stabilized instruments similarly can be tailored.—*Trio Laboratories, Inc., 4025 Merrick Road, Seaford, N. Y.*

For more information circle **416** on inquiry card.

SUBMINIATURE DC SUPPLIES

New subminiature highly-regulated dc power supplies, in many sizes and ratings from 5 v for strain gages to

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Mfrs. of Industrial Laboratory Recording and Dial Thermometers

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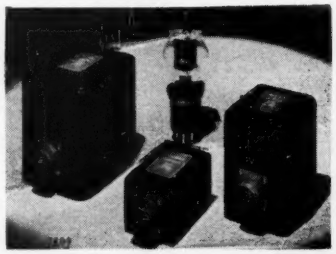
NEW INSTRUMENTS

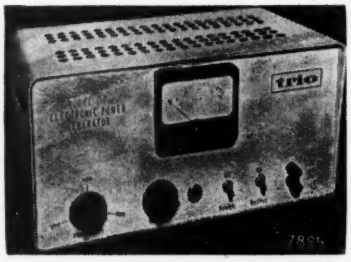


550 v for regulated plate voltage, contain no vacuum tubes or transistors but are of magnetic-amplifier type.—*Arnoux Corp., Dept. IR-5, Box 34628, Los Angeles, Calif.*

For more information circle **417** on inquiry card.

FREQUENCY SUPPLIES

New "Model DP Metered Electronic Power Generators" deliver up to 100 va of low-distortion power at any



fixed frequency between 50 and 5000 cps. Four standard models (400 cps, 1000 cps, 1600 cps, and 2000 cps) are available in two versions: single factory-set frequency, or variable frequency panel-controlled over a range of ±5% of nominal.—*Trio Laboratories, Inc., 4025 Merrick Road, Seaford, N. Y.*

For more information circle **418** on inquiry card.

HV RF POWER SUPPLIES

Two new models are added to maker's line of low-cost high-voltage radiofrequency power supplies. "Model

15BR" delivers 2-15 kvdc with 1 ma @ 10 kv; "Model 30BR" delivers 5-30 kvdc with 1 ma @ 20 kv. Both have regulation of better than 1%.—*Neutronic Associates, 87-16 116th St., Richmond Hill 18, N. Y.*

For more information circle **419** on inquiry card.

DRIFT FREE DC μV AMPLIFIER

The **KAY LAB MODEL 111** amplifier provides the lowest drift of any commercially available broadband d-c amplifier. The unique circuit incorporates **KAY LAB's** proven chopper amplifier system to provide unsurpassed dynamic performance — unaffected by load or gain changes. Available in a single-unit cabinet or a six-amplifier rack-mountable module only 19 inches wide, the **Model 111** is ideal for data reduction facilities, or as a strain gage amplifier, recorder driver amplifier, or general purpose laboratory amplifier.

SPECIFICATIONS

- ± 2 uv equivalent input drift
- Integral power supply
- ± 35V, ± 40 ma output
- 100,000 Ω input impedance
- 0 to 1000 gain in ten steps
- ± 1% gain accuracy
- 5 uv peak equivalent input noise
- Price (Single) Amplifier $550.00

Representatives in All Major Cities

KAY LAB

5725 KEARNEY VILLA ROAD
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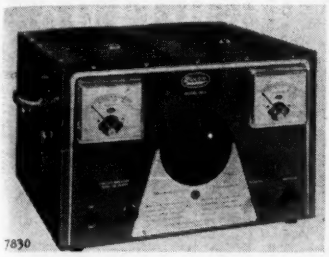
For more information circle **141** on inquiry card.

DC POWER SUPPLY

New "Model NFA" features less than ¾% ripple at top load of 15 amp; continuously variable voltages



from 0 to 32 and versatility to test almost all electronic equipment. A unique application is said to increase selenium rectifiers' power rating and to provide "lower cost per ampere output."—*Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **420** on inquiry card.

DC AMPLIFIER

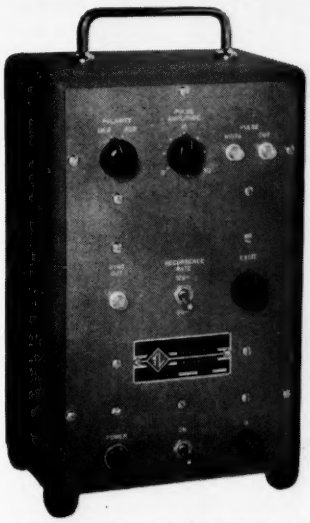
New "Model 111" chopper stabilized broadband dc amplifier features ten feedback-controlled gain ranges from 20 to 1000; gain accuracy 1%; 2-uv drift said to be "the lowest drift of any commercially available broadband dc amplifier." Input impedance 100,000 ohms; output impedance less than 1 ohm; frequency response ±0.3 db to 10 kc and less than 3 db down at 40 kc; equivalent input noise less than 5 uv peak-to-peak from 0 to 3 cps and less than 12 uv rms from 0 to 50 kc. Integral power supply. Amplifier output capability is ± 35 volts or ± 40 ma.—*Kay Lab, 5725 Kearney Villa Rd, San Diego 11, Calif.*

For more information circle **421** on inquiry card.

DC SIGNAL AMPLIFIER

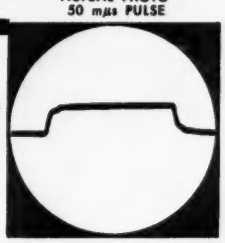
New the "Micromag MMO-422" low-level magnetic dc signal amplifier, for telemetering and instrumentation applications, utilizes a transistor oscillator to operate directly from a dc power source so that gain is free from variations normally en-

MILLI-MICROSECOND PULSE GENERATOR



- Practically ideal rectangular pulses at recurrence rates of 60 or 120 pulses per second
- Rise and decay times down to 1.2 mμs, minimum width 1.2 mμs, maximum duration unlimited
- Amplitude 0 to 35 volts with 93 ohms load, may be adjusted using standard DC voltmeter
- Sync output signal isolated from the main output with provisions for delaying the main pulse
- Time parameters determined by standard RG-62/μ coaxial cable or accessory width and delay unit

ACTUAL PHOTO
50 mμs PULSE



MODEL PG-215 PULSE GENERATOR $245.

MODEL PGA-220 WIDTH & DELAY UNIT (optional) $195.00

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For ambient temperature tests in the LABORATORY or on the PRODUCTION LINE, the Model TC-2 Temperature Test Chamber is ideal. Interchangeable extra test trays may be ordered to eliminate loading delays in continuous production tests, or for convenience in special test work.
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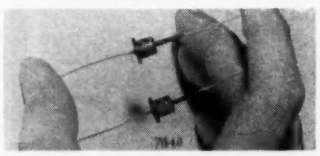
For more information circle **143** on inquiry card.

countered when excitation is provided by a 400-cps line supply subject to a ± 10% tolerance. It provides ripple-free 5 vdc output from 1-mvdc signal input. All-magnetic construction assures stability under the most severe operating conditions.—*Magnetic Research Corp.*, 200-202 *Center St., ElSegundo, Calif.*

For more information circle **422** on inquiry card.

HI-TEMP SILICON RECTIFIERS

New "1N537 and 1N538" silicon rectifiers have rated maximum dc output current of 250 ma at 150°C (up



to 750 ma where lower temperatures are encountered). "1N537" maximum peak inverse voltage is 100; "1N538" PIV is 200 v. Maximum surge current for both is 10 amp.—*Semiconductor Products, General Electric Co., Electronics Park, Syracuse, N. Y.*

For more information circle **423** on inquiry card.

ELECTRICAL COMPONENTS

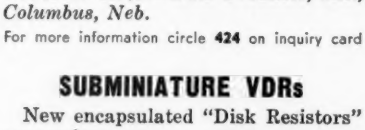
MINIATURE POWER RESISTOR

New "Dalohm PH-25 Powerhouse" 25-watt resistor features a unique finned design of heat-dissipating housing. New single-hole panel mounting simplifies design where space is limited. Average weight of complete unit is 15 grams. Standard resistance values from 0.1 ohm to 15,000 ohms with tolerances from 0.05% to 5.0%.—*Dale Products, Inc., Columbus, Neb.*

For more information circle **424** on inquiry card

SUBMINIATURE VDRs

New encapsulated "Disk Resistors" can replace two or more precision resistors employed as voltage dividers.



Matched ratios over wide temperature ranges are possible with resistance wire matched to within 5 ppm/C°. Units withstand high humidity and temperatures to 125°C.—*Eastern Precision Resistor Corp.*, 675 *Barbey St., Brooklyn, N. Y.*

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BUSHING INSULATION
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ADVANTAGES . . .

- good dielectric strength (500 to 1000 volts/mil)
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- no change of electrical properties with temperature (-25°C to +250°C) or frequency (60 cycles to 100 mc).
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PF spaghetti tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon* is also available.

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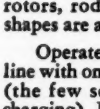
*"Teflon"—DuPont trade name for Tetrafluoroethylene resin

For more information circle **144** on inquiry card.

RECOMMENDED BY LEADING MAGNET MAKERS

This high powered condenser discharge unit will saturate large Alnico and ceramic permanent magnets of any shape, using interchangeable, plug-in pulse transformers or wire-wound fixtures. 100,000 ampere-turn output of basic unit can be increased to 200,000 ampere-turns at any time by adding 100 μf condenser banks and appropriate pulse transformer. Adapters for multi-pole rotors, rod, bar, ring and various other shapes are available.

Operates from regular 115 volt, 60-cycle line with only intermittent 10-ampere drain (the few seconds when condensers are charging). Mounted on casters for convenient mobility. Price of basic unit with pulse transformer is less than $2,000.



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Our 12 years of magnet charging experience is yours for the asking — send a sample magnet or sketch for free charging analysis.

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Radio Frequency
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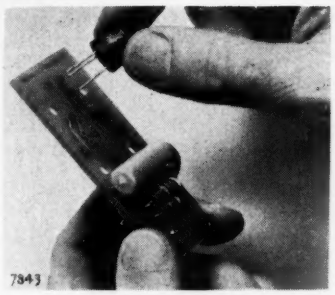
Boonton, New Jersey, U.S.A.

For more information circle **145** on inquiry card.

DIRECT-MOUNTING VDR

New "PC-5" wire-wound voltage-dividing resistor mounts directly on graphic-circuit boards without screws

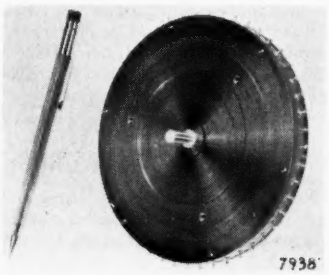


and lugs; is easily adaptable to automatic installation techniques.—*George-Held, Inc.*, 1020 *North La Brea, Los Angeles* 38, *Calif.*

For more information circle **426** on inquiry card.

MULTI-TAP PRECISION VDR

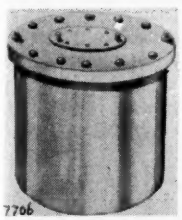
New 48-tap version of "RL-270A-5 Precision Potentiometer" gives 47 equal resistance sections, while main-



taining guaranteed linearity of 0.1%. Total resistance of 500,000 ohms affords a resolution of 0.0075% (13,000 turns).—*The Gamewell Co., Newton Upper Falls* 64, *Mass.*

For more information circle **427** on inquiry card.

LOW-INDUCTANCE CAPACITORS



New low-inductance capacitors, for applications requiring high peak energy within a short time constant, feature a unique design which minimizes magnetic flux; are hermetically-sealed. Stock ratings available from 500 joules @ 25 kv with 0.025 uh inductance to 8000 joules @ 125 kv with 0.065 uh inductance. (Others to order.)—*Axel Bros., Inc.*, 134-20 *Jamaica Ave., Jamaica* 18, *N. Y.*

For more information circle **428** on inquiry card.

ULTRA LOW-LOSS QUARTZ TRIMMER CAPACITOR

New "Model VC11A Fused Quartz Piston Capacitor," for use in capacitor networks requiring low-loss and

Highest Accuracy. . . Minimum Size for Field, Lab, and Production Use

There's a Shallcross Bridge for measuring resistance to any desired precision—indoors or out. Field models have aluminum cases with controls easily adjustable even with a gloved hand. Models for lab, production, and school use feature high readability and simple operation—even for unskilled users.

Accuracy, Stability, and Ruggedness—unsurpassed in any instrument of comparable price.

Selections from the complete Shallcross line are described below. Additional specifications on these, and many other types, are available from SHALLCROSS MFG. CO., 510 Pusey Ave., Collingdale, Pa.

Deliveries from Stock ✓

WHEATSTONE—FAULT LOCATION BRIDGE No. 6100: 5-dial field model. Locates grounds, crosses, opens, and shorts by Murray, Varley, Hilborn, or Fisher Loop and Capacitance tests. Range: 1 to 1,011,000 ohms. Accuracy: ± 0.1%, + 0.01 ohm. 8⅞" x 7⅜" x 5¾". 8 lbs. *Price: $175.*

KELVIN-WHEATSTONE BRIDGE No. 638-R: Shallcross has pioneered this compact combination of two bridges in one. Range: 0.001 to 11,110,000 ohms. Accuracy: ± 0.3% − 1 to 111,100 ohms. 12½" x 10½" x 6¾". 9 lbs. *Price: $260.* ✓

WHEATSTONE-LIMIT BRIDGE No. 6320: Combines 5-dial Wheatstone and Percent-Limit features. Range: 0.1 to 111,110,000 ohms. Accuracy—*Ratio resistors:* ±.01%, *Rheostat:* ± (.01% to .05% + .005 ohms). 15¾" x 9¼" x 5½". 15 lbs. *Price: $700.*

Shallcross

For more information circle **146** on inquiry card.

direct measurements on TRANSISTORS!

. . . using MEASUREMENTS'

STANDARD TEST SET

for Transistors

Model 505

- Provides rapid "go-no go" transistor testing — important for quality control, production, engineering groups.
- Useful for comparison of incoming or untested transistors with a reference transistor which meets device specifications.
- Extremely flexible — utility and type of measurement can be established by use of auxiliary equipment — makes all measurements.
- "h" or "r" parameters are measured by connecting external test equipment to applicable jacks and terminals on front panel.

Measurements' Model 505 Standard Test Set for Transistors is a self-contained, battery-powered instrument designed for rapid d-c measurement of important junction transistor parameters. Permits multiple testing of PNP and NPN small-signal, medium-power, and switching (computer) transistors.

SPECIFICATIONS

DIRECT MEASUREMENTS: Makes fundamental d-c measurements on small-signal, medium-power, and switching transistors operating in the common-emitter configuration.
Measures collector-to-emitter leakage current from 0 to 10 ma; measures collector current from 0 to 10 ma.
Measures direct current gain (d-c Beta) or "incremental current gain" from 0 to 200, or as calibrated. Indicates G_m from 0 to 0.39 mhos.

AUXILIARY MEASUREMENTS: External test equipment can be used for dynamic measurement of "h" or "r" parameters and switching transistor characteristics up to the megacycle region for selected values of operating biases.

POWER SUPPLY: Collector supply voltages of 6 and 12 volts from internal batteries, or from suitable external power supply.

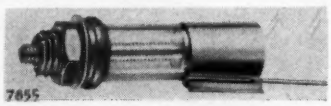
Laboratory Standards

MEASUREMENTS CORPORATION

BOONTON • NEW JERSEY

For more information circle **147** on inquiry card.

NEW INSTRUMENTS



high leakage resistance for 400-cps operation, is also recommended for ultra-stable oscillator circuits and as a tuning element in high-frequency low-power tank circuits.—*JFD Mfg. Co., Inc.*, 6101—16*th Ave., Brooklyn* 4, *N. Y.*

For more information circle **429** on inquiry card.

ELECTRONIC COMPONENTS

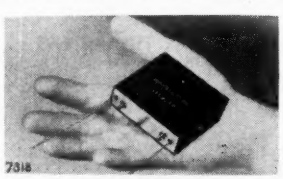
PHOTOTRANSISTOR

New "Type GT-66" miniature germanium *p-n-p* alloyed junction three-lead phototransistor, for use in circuits employing ac amplification for modulated light, can also be used as a two-lead device with unmodulated light; responds to visible and infrared (to 2.1 microns). Photosensitive area is a "point" (1 mm² average area).—*General Transistor Corp.*, 130-11 90*th Ave., Richmond Hill* 18, *N. Y.*

For more information circle **430** on inquiry card.

SUBMINIATURE FILTERS

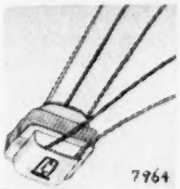
New subminiature (2½" long) filters designed for IF amplifiers for printed circuit use are temperature



compensated to 0.15% from—55°C to 85°C.—*Burnell & Co., Inc.*, 45 *Warburton Ave., Yonkers* 2, *N. Y.*

For more information circle **431** on inquiry card.

TRANSISTOR TRANSFORMERS



New ultra-miniature push-pull transistor transformers, available for immediate delivery, measure ⅜" x ⅜" x 11/32"; weigh 0.005 lb; have 4" color coded leads suitable for use in dip-soldered printed circuits. Also available for single-ended and vacuum-tube applications.—*Microtran Co., Inc.*, 145 *E. Mineola Ave., Valley Stream, N. Y.*

For more information circle **432** on inquiry card.

TELEMETERING FILTERS

New line of miniature telemetering filters is said to be complete. Photo shows typical miniature bandpass filter in MIL style GB case. It has 15% bandwidth at ±1 db and phase shift linearity within 5%. Attenuation at 15% from center frequency is 30 db.—*Hycor, Div. International Resistance Co.*, 12970 *Bradley Avenue, Sylmar, Calif.*

For more information circle **433** on inquiry card.

LONG-DELAY NETWORKS

New custom-designed long-delay high-impedance distributed-constant delay networks are constructed with

radial leads for graphic-board wiring; can be supplied to meet low-cost commercial requirements or military specs. Commercial units can be provided in hermetically-sealed cases, and with terminals arranged exactly for printed circuit boards.—*ESC Corp.*, 534 *Bergen Blvd., Palisades Park, N. J.*

For more information circle **434** on inquiry card.

BALZERS *Thin Film Optics*

From the Principality of Leichtenstein Swiss Customs Area

ROLYN ARCADIA (Calif.)

Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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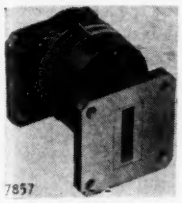
Balzers means research in high vacuum process

For more information circle **148** on inquiry card.

FERRITE ISOLATORS



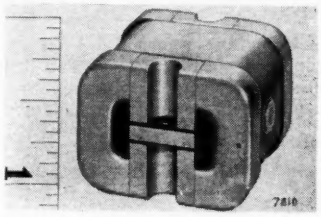
New ferrite isolators utilize a new field displacement resonance absorbtion technique with ferrite material acting as a resonant dielectric waveguide. Db ratios of isolation to insertion loss as high as 500 to 1 have been recorded. New isolators are custom-designed. Illustrated is "Model 165-1A" for 8800 Mc, 50 watts average power, 25 db isolation and 0.25 insertion loss, or a db ratio of 100 to 1.—*Kearfott Company, Inc. (Western Div.)* 253 *Vinedo Ave., Pasadena, Calif.*

For more information circle **435** on inquiry card.

ELECTROMECHANICAL COMPONENTS

SHORT-STROKE MOTOR

New "Model 24 Torque Motor" weighs 11½ oz; has output conservatively rated at 8 lb of force for 3



watts of input power; is designed to drive hydraulic servovalves, etc. Stroke is ±0.01" and is proportional to input differential current.—*Raymond Atchley, Inc.,* 2340 *Sawtelle Blvd, Los Angeles* 64, *Calif.*

For more information circle **436** on inquiry card.

ROTARY SOLENOID

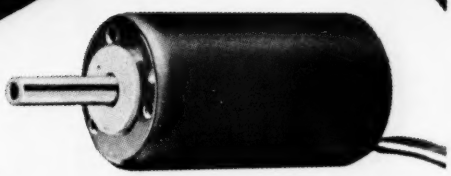
New "Model BD1E" 1"-dia rotary solenoid, smallest of maker's eight basic sizes, weighs 1½ oz, has a starting torque of 0.2 lb-in based on ampere-turns for normally intermittent duty cycle and rotary stroke of 45°. Standard rotary strokes are 25°, 35° and 45° clockwise or counterclockwise. Most features available on other seven models can be had.—*G. H. Leland, Inc.,* 123 *Webster St., Dayton, Ohio.*

For more information circle **437** on inquiry card.

P-M GEARHEAD MOTORS

New "BYLM" permanent-magnet type motors have gearheads with maximum torque output of 5 to 10

HEART of your miniaturization program



the EAD 1" MOTOR

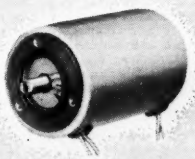
Here is EAD's outstanding contribution to the miniaturization program . . . a one-inch diameter, 400 cycle precision motor, engineered for long life and high efficiency. Where minimum size and weight are essential, use this versatile unit. Modifications include high ambient and high altitude versions as well as low voltage designs.

MINIATURE TUBE AXIAL BLOWERS
For efficient cooling and air change in small electronic equipment. Driven by EAD's 1" dia. motor. No brushes, no arcing, no interference.

SUBMINIATURE CENTRIFUGAL BLOWERS
For spot cooling. Moves 9 CFM at 1.35 S.P. Powered by EAD's 1" dia. motor.

MINIATURE RING MOUNTED FANS
For peak performance, compactness, dependability. Blade dia. small as 2" — air del. greater than many heavier blowers. Uses EAD's 1" dia. motor.

MINIATURE GEAR MOTORS
Servo, synchronous or induction units, primarily for 400 cycle and var. freq. operation. Gear ratios up to 10,000 to 1. Basic types use EAD's 1" dia. motor.



MINIATURE SINE WAVE ALTERNATORS
For very pure sine wave voltage, high power output. Low distortion, light weight, permanent magnet fields. Frame sizes begin with 1" diameters.

Complete specifications available on request.

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For more information circle **149** on inquiry card.

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NEY

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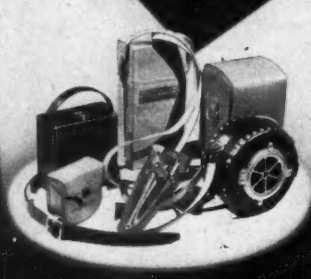
For more information circle **150** on inquiry card.

A CASE FOR YOUR PRODUCT . . .



Protect your product.
Stimulate its sale.
Use Leather Cases by . . .

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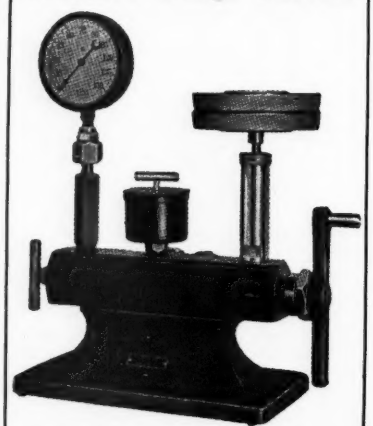
For more information circle **151** on inquiry card.

AMTHOR Dead Weight Pressure Gauge TESTER



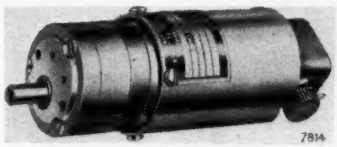
Designed for simplicity and compactness, this tester incorporates the newest refinements and improvements and is praised by users in all industries for long lasting troublefree service. Made in ranges up to 10,000 P.S.I. We guarantee accuracy of 1/10 of 1%. Supplied in metal carrying case with adapters and tools. Weights in special metal container for storing.

Immediate attention will be given to inquiries on your testing problems.
Ask for literature.

Amthor Testing Instrument Co., Inc.
45 Van Sinderen Ave., Brooklyn, N. Y.

For more information circle **152** on inquiry card.

NEW INSTRUMENTS



lb-in (shown) and up to 500 lb-in (not-shown); outputs up to 1/10 hp; speeds from 5000 to 20000 rpm less gearhead. Gear ratios for illustrated unit are available from 9.5 to 55,-466/1.—*Aircraft Controls Div., Barber-Colman Co.,* 1400 *Rock St., Rockford, Ill.*

For more information circle **438** on inquiry card.

MOTOR-TAC GENERATOR

New synchronous motor and tachometer generator combines maker's "Type MC" motor, "SC" two-phase

generator and a special 3:1 spur gear reducer; operates on 115 vac, single phase, 400 cps. Two-phase sine-wave output 20 volts/rpm per phase at 200 cps; harmonic content normally less than 5%.—*Globe Industries, Inc.,* 1784 *Stanley Ave., Dayton* 4, *Ohio.*

For more information circle **439** on inquiry card.

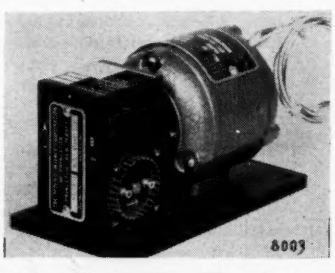
SILICONE INSULATED WIRE

New silicone rubber insulated wire, designed for high-temperature resistance (up to 500°), is said to be "ideal for small conductors in many electronic applications."—*Continental Wire Corp., Wallingford, Conn.*

For more information circle **440** on inquiry card.

SAMPLING SWITCH

New "Type AA" multichannel sampling switch for telemetering, display systems, programming, etc., features



2 poles with 24, 30 or 32 contacts per pole and sampling rates up to 6 rps. Special construction allows manual phasing of both poles through 360°.—*Applied Science Corp. of Princeton, P.O. Box* 44, *Princeton, N. J.*

For more information circle **441** on inquiry card.

BUTTONLESS VIBRATOR

New "Series 1600" represents a completely new design: instead of conventional contact buttons, it utilizes vibrating reed and side arms themselves as contacting elements by designing these parts of special contact alloy, whence "far greater contact area, and from 50 to 100% longer vibrator life in service."—*P. R. Mallory & Co. Inc., Indianapolis 6, Indiana.*

For more information circle **442** on inquiry card.

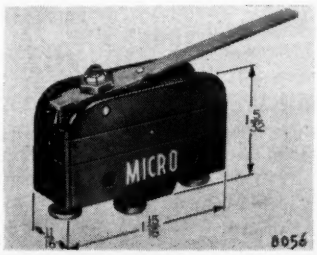
COLLECT FITTING KNOB

New "Type MK-2" military style knob for flatted shafts incorporates "Dalohm" positive locking collet which prevents inoperativeness due to loosening on shaft. Material is a tough thermosetting plastic. Wide choice of skirts, dial plates and pointers.—*Dale Products, Inc., Columbus, Neb.*

For more information circle **443** on inquiry card.

LEVER SWITCH

New "BZ-2 RW 899 A2" adjustable-lever-actuated basic switch has operating position adjustable between



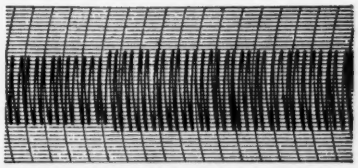
0.670" and 0.880"; is particularly well suited for use on timers, computers or other multi-mounted switch devices; is available in straight or formed lever designs; with or without a roller; solder type or screw terminals; wide selection of preset operating characteristics. All models are listed by UL at 15 amp 125, 250 or 460 vac; ½ amp 125 vdc; ½ amp 250 vdc.—*Micro Switch Div. Minneapolis-Honeywell, Freeport, Ill.*

For more information circle **444** on inquiry card.

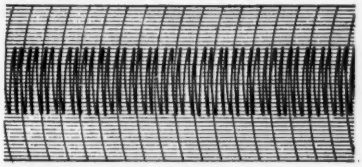
MINIATURE DC RELAY

New "Type S" miniature dc relay 1" high overall, is suitable for use in low-cost equipment, radiosondes, ex-

Regulation in *less than 1/50th cycle...*



Output of typical electromechanical regulator in response to step change in input voltage. Average correction rate of 6v. per sec.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Full recovery in 330 microsec.

Simultaneous two-pen recording of 60 c.p.s. voltage

PLUS Pure Sine Wave Power

CURTISS-WRIGHT LINE REGULATOR

- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
- **Reduces typical power line distortion to less than 0.3%.**
- **Furnishes 1.4 KVA of distortion-free power.**
- **Introduces no phase shift between input and output.**
- **Simultaneously provides additional 4 KVA of ±1% electromechanically regulated power.**

Faster recovery time (less than 1/50th cycle, or 330 microseconds) plus the unique ability to *eliminate* line distortion — these are the reasons why the Curtiss-Wright Distortion Eliminating Voltage Regulator has been chosen by more and more laboratories and production test departments. Besides general laboratory use, this line regulator provides simpler, more accurate calibration of meters . . . better design of transformers, synchros, motors . . . easier testing of such components, with fewer rejects . . . easier, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance . . . elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

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For more information circle **153** on inquiry card.

Electroplated
WIRE
For Many Different Applications
Specialists in the Unusual
More and more people are turning to us for electroplated wire. We electroplate by continuous methods a wide variety of wire in a range of diameters from .035" to the smallest available. In our laboratory, Tungsten wire as small as .00015" has been electroplated with Gold . . . New applications for electroplated wires on different base materials are being developed from time to time . . .
Your inquiry is invited. Consult our staff, without obligation, about your specific wire problems.
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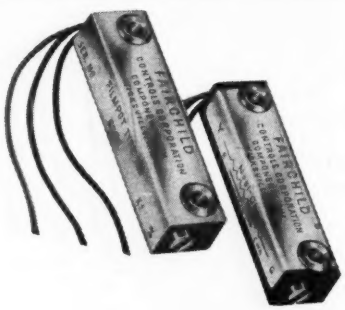
Write for List of Products.

For more information circle **154** on inquiry card.



Fairchild FilmPot® trimmers are high quality potentiometers offering operating characteristics of infinite resolution, precision adjustment, and stability of performance over a temperature range from −55 to +175°C. The Nobl-Ohm® metallic film resistance elements are evaporated continuous films of precious metal alloys.

METALLIC FILM TRIMMERS

The Types 768 and 769 FilmPot trimmers feature the exclusive Fairchild Nobl-Ohm resistance element in two small size, light weight units. Resistance range 50 to 25,000 ohms ±10%; infinite resolution; linearity ±5%; −55°C to +175°C operating temperature. Type 769 measures $^{11}/_{32}$ x $^{13}/_{32}$ x $1^{21}/_{64}$ and the smaller type 768 is ¼ x ⅜ x 1¼ inches. Both types permit close stacking, and adjustment is obtained by a 28½ turn screw.

The answer to all your precision potentiometer problems can be found at Fairchild. For information write: Dept. 140-78B, Fairchild Controls Corporation, Components Division, 225 Park Ave., Hicksville, L.I., N.Y.

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PRECISION POTENTIOMETERS and COMPONENTS

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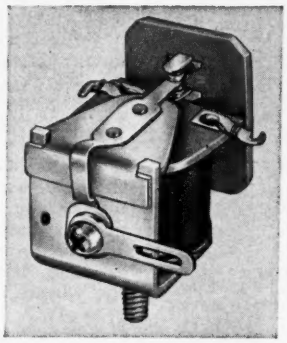
For more information circle **155** on inquiry card.

NEW INSTRUMENTS

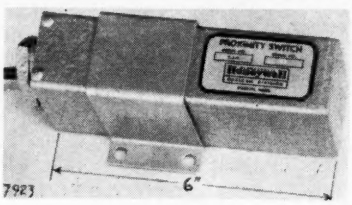


pendable devices, printed circuits, etc. Sensitivity 40 mw; contact rating 1½ amp at 115 vac; sp-dt; cross-bar contacts available.—*Comar Electric Co., 3349 W. Addison St., Chicago 18, Ill.*

For more information circle **445** on inquiry card.

PROXIMITY SWITCH

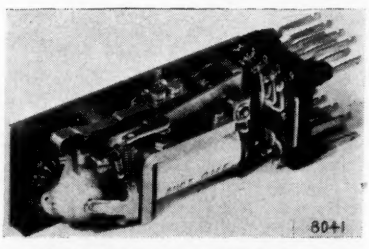
New magnetic switch detects objects containing iron on assembly lines, in liquids, etc.; has no moving parts; requires no physical contact with workpiece. Sensing poles are designed to detect metal objects within ⅛" of face. Thus, in machine tool operation, switch cannot be set off by falling chips.—*Doelcam Div., Minneapolis-Honeywell Regulator Co., 1400 Soldiers Field Rd., Boston, Mass.*



For more information circle **446** on inquiry card.

HIGH-SPEED STEPPING RELAY

New "Type 7500/12," comprising a 12-point arc assembly, rotor assembly and driving motor, has a stepping speed of 80 steps per second with stepping pulses of a 50/50 make-break ratio. An impulse type of driving motor is used in standard unit with a 48-vdc 244-ohm coil. (Other voltages on special order). Relay's life exceeds ten million revolutions.—*International Standard Trading Corp., 22 Thames St., New York 6, N. Y.*

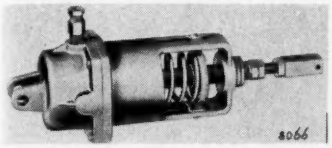


For more information circle **447** on inquiry card.

MECHANICAL COMPONENTS

DIAPHRAGM MOTOR

New three-inch "Powerstroke" diaphragm motor supplements 4" and 6" sizes; operates on air, water or oil

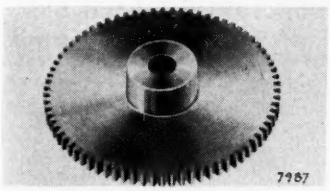


pressure; provides thrusts to 80 lb; maximum stroke 2⅛"; is intended for gradual push-pull control of levers, etc. Strokes and starting pressures are adjustable.—*The Powers Regulator Co., 3434 Oakton St., Skokie, Ill.*

For more information circle **448** on inquiry card.

GEARS

New spur pinions and gears are available with either solid hub and set screw (for economical general use) or

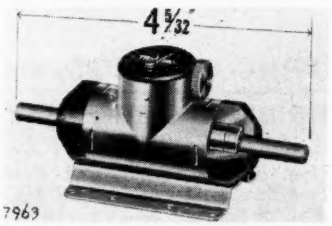


split hub (for precise alignment of gear to shaft). Stainless steel pinions, face width 0.145", 20 to 36 teeth. Anodized aluminum gears, face width 0.125", 37 to 100 teeth as well as 120 and 160 teeth.—*Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, L.I., N. Y.*

For more information circle **449** on inquiry card.

ADJUSTABLE-RATIO SPEED CHANGER

New improved model of maker's adjustable ratio speed changer has anodized aluminum end bells with two

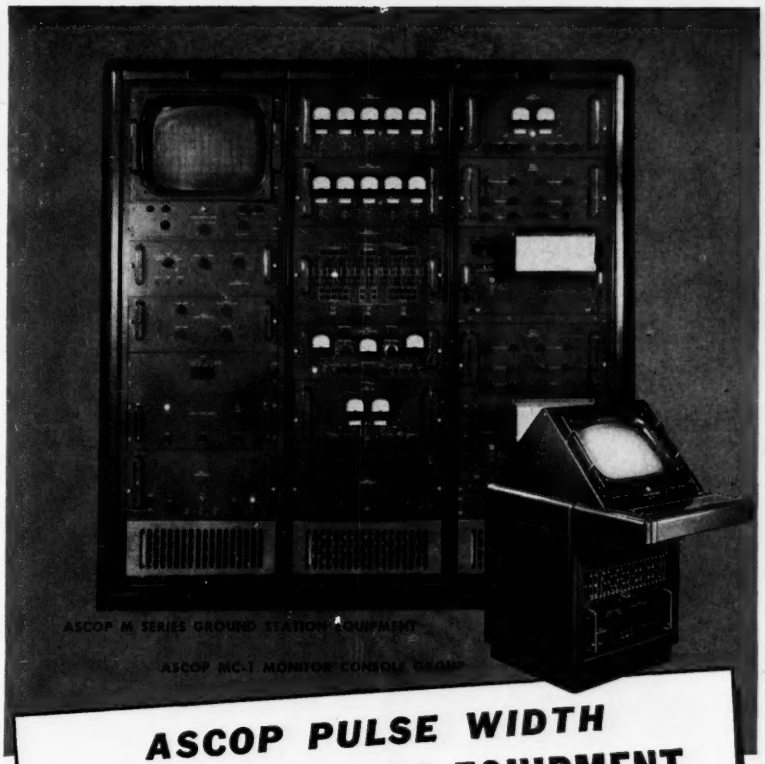


pressed fit ball bearings for each shaft. Concentricity between input and output shafts is held even closer than on former models which had phenolic end bells. —*Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

For more information circle **450** on inquiry card.

RETAINING RINGS

New "Series 3000" internal retaining rings are available in 37 sizes, conform to National Aircraft Stand-



ASCOP PULSE WIDTH

GROUND STATION EQUIPMENT

Achieves System Accuracies of Better Than 1%

PROVIDES FOR:

- **Advance Station-Calibration, using locally generated setup signals**
- **Continuous Automatic Compensation for system zero, scale factor changes**
- **Simultaneous Visual Monitoring of all data channels**
- **Missing Data Point Correction, for continuous synchronization**
- **Real Time Reduced Output Records for any or all channels**
- **Easy Access to Slide Mounted Chassis, even during operation**

Stations are sold only as combinations of standard or special tape recorder, monitor, decommutation or output recorder groups.

ASCOP Pulse Width Ground Station equipment, pictured above, complements ASCOP's PW Multicoders and Radio Telemetering Sets to provide complete "packaged" systems for operational testing of aircraft, missiles and other vehicles . . . and for static testing of engines, rockets, nuclear reactors and other powerplants.

Continuous automatic compensation of system zero and scale factor eliminates the need for critical components and frequent manual adjustment.

The M Series Ground Station uses intermediate magnetic tape speed change to operate directly from pulse width signals of 30x30, 45x20, or 90x10 configurations—or from any non-standard configuration having 30, 45 or 90 channels. All data channels may be visually monitored simultaneously.

All ASCOP equipment is designed for dependable accuracy, simplicity of operation, maximum life with minimum maintenance attention. ASCOP engineers will gladly consult with you, without obligation, on your current projects. Or write for detailed information, outlining your system requirements.

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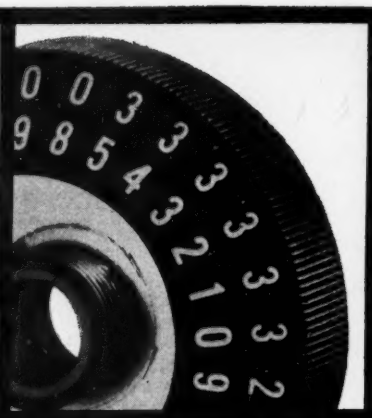
ASCOP

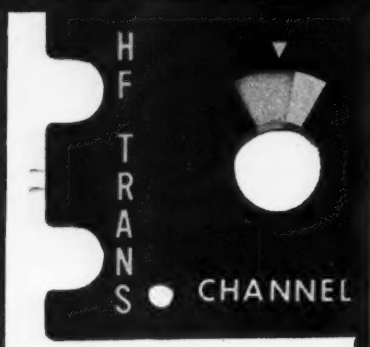
WE PROVIDE THE LEVER YOU MOVE THE WORLD

For more information circle **156** on inquiry card.

have you
Edge Lighting Problems?

The unparalleled design flexibility of the Lackon® photo-marking process may offer you the best solution. With a minimum of gimmicks and gadgetry, Lackon® gives you a panel of unequalled marking accuracy, optimum legibility and lighting uniformity, with excellent resistance to severe environmental conditions. Designed, tested and quality controlled in our government approved laboratory, Lackon® edge lighted panels, knobs and knob skirts meet and exceed lighting, legibility and durability requirements of specification MIL-P-7788.





The Lackon® engineering staff of the United States Radium Corporation will readily assist your panel engineering department during the initial design stage. The cooperative application of their skill and experience in lighting techniques will speedily resolve design difficulties, result in decided production economies, and yield a remarkably superior finished product. For information write Dept. IA-10

United States Radium Corporation
Hanover Ave., Morristown, N. J.

Regional Offices: 5420 Vineland Ave., N. Hollywood, Calif.; 4624 W. Washington Blvd., Chicago, Ill. Affiliates: In Canada – Radelin-Kirk Ltd., 1168 Bay St., Toronto, Ont.; In Europe – United States Radium Corp.–Europe, 36 Avenue Krieg, Geneva, Switzerland.

For more information circle **157** on inquiry card.

NOISE PROBLEM?

LEAVE IT HERE

RELY ON THE

SKL VARIABLE ELECTRONIC FILTER

. . . For eliminaton of unwanted signals in your data

. . . For studies in vibration, dynamics, telemetering, acoustic noise and speech

. . . Continuously variable pass band permits clean recordings of only the data you want

. . . As well as selection of discrete frequencies when recording or analyzing data

Send for Bulletin 300 for further information on SKL products

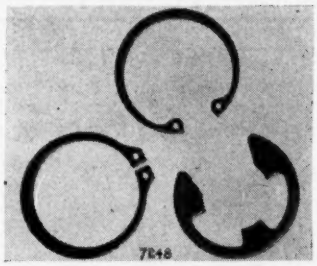
FEATURES:

- CONTINUOUSLY VARIABLE FOR HIGH-PASS, LOW-PASS, BAND-PASS AND BAND-REJECT
- CUT-OFF RANGE 20 cps to 200 KC
- ATTENUATION 36 db/octave max.
- ZERO INSERTION LOSS
- FREQUENCY RESPONSE 2 cps to 4 mc
- NOISE LEVEL 60 microvolts

SKL
SPENCER-KENNEDY LABORATORIES, INC.
1320 SOLDIERS FIELD ROAD
BOSTON 35, MASS.

For more information circle **158** on inquiry card.

NEW INSTRUMENTS

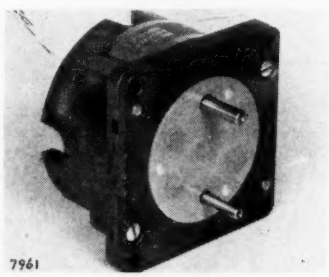


ards 50 and are applied axially into housings. "Series 3100" rings are made in 47 sizes, conform to NAS 51 and are applied axially to shafts. Both series, as well as maker's original "Series 1000" open-type rings, are available in carbon spring steel, stainless steel, phosphor bronze, and beryllium copper. Choice of many finishes. —*Industrial Retaining Ring Co., 8 West Sidney Ave., Mount Vernon 69, N. Y.*

For more information circle **451** on inquiry card.

DUAL OUTPUT GEAR BOX

New 'Model 013" provides primary and secondary output shafts for use in servo systems where two constant



ratio outputs are required. In some instances it eliminates a second servo system. Adapter kits are available to facilitate utilization of new gear box with various standard servomotors.— *Link Aviation, Inc., Binghamton, N. Y.*

For more information circle **452** on inquiry card.

TUBING, FITTINGS, etc.

TRANSPARENT REINFORCED PLASTIC HOSE

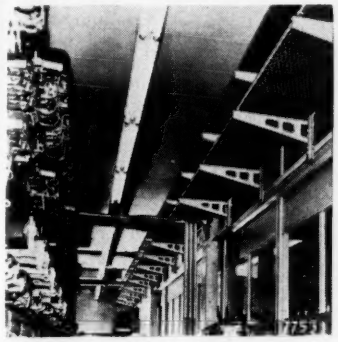
New BARDEX reinforced plastic tubing, in sizes from ⅛" to 1" ID, is useful for fuel and oil lines, also suitable for use as an electrical conduit, requiring no joints or ground wires. Made from PVC, new tubing is extruded with a spiral steel wire reinforcement within wall, out of reach of fluids passing through or from outside abrasions. One advantage is guaranteed constant bore even if hose is bent or knotted. Completely weatherproof; self-extinguishing; resistant to gasoline, sea water, oils, high octane fuels, coal and butane gases and chemical solutions. Working tempera-

tures 170°F down to 5°F. Typical recommended pressures from 200 psi for ⅛" ID to 100 psi for ½" ID.—*Newage International, Inc., 222 York St., Jenkintown, Pa.*

For more information circle **453** on inquiry card.

TUBING TROUGH SUPPORT

New "Rakit" cantilever-type support for maker's system of expanded metal trough for instrument tubing

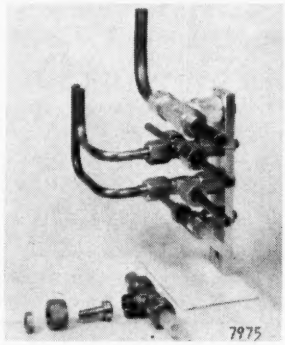


is secured by a twist of the wrist. Upright channel irons have pre-punched holes to provide a wide number of possible settings.—*Instrof Corp., Collegeville, Pa.*

For more information circle **454** on inquiry card.

TUBE-FITTING ANCHOR

New tube fitting anchor or mounting stud is a bolt type adapter made in both "Intru-lok" (brass flareless

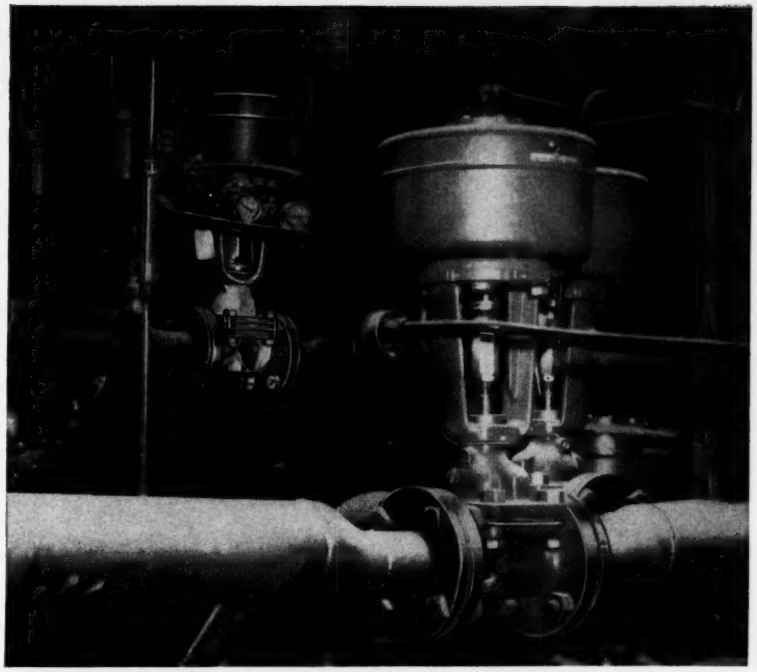


type fittings especially for instrumentation lines) or "Triple-lok" (flare type fittings); is used to mount a tee or cross fitting directly to a bracket or in a threaded boss.— *Fittings Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.*

For more information circle **455** on inquiry card.

THREAD-CHANGE ADAPTER

New "FG5-S" adapter facilitates changeover from pipe threads to straight threads in various applications such as valves or other units too large to be removed to a bench for remachining of ports. "F" signifies a male pipe threaded end, "G5" indicates internal straight thread o-ring boss on other end, and "-S" denotes steel as material: After pipe



LEADING MANUFACTURER CUTS SERVICE COSTS

with CONOFLOW AIR-OPERATED · SAUNDERS PATENT VALVES

This leading pigment manufacturer has little worry of being burdened by service problems with these Conoflow valves installed high up in the air in an inaccessible location. The illustration shows Saunders Patent Valves with Cylinder Conomotor Operators on an important application in a titanium processing operation at our customer's midwestern plant. Numerous successful installations in their several plants have convinced them of the dependability of Conoflow valve assemblies.

The Conoflow-Saunders Valve is a compact, lightweight unit which can be mounted in any position. The streamlined flow area of the valve body is free from pockets, grooves or crevices which cause clogging and sticking of slurries and semi-solids. Unique diaphragm gives tight shut-off and can be easily replaced. Positioners have no exposed moving parts.

Conoflow-Saunders Valves range in size from ½" all the way up to 12". They are available for "on-off" or throttling control service, using Conomotor operators specifically designed for automatic and remote control in conjunction with pneumatic instruments.

Cono-Controls®
FOREMOST
IN FINAL CONTROL ELEMENTS

Catalog HB-5 describes Conoflow Saunders Patent Valves in detail. Write for your copy today. Conoflow representatives are located in most principal cities.

CC-605

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2100 ARCH STREET • PHILADELPHIA 3, PA.

For more information circle **159** on inquiry card.

ULTRASONIC CLEANING BY THE SQUARE FOOT

Recent improvements in ultrasonic power-generating equipment, and the perfection of hermetically-sealed transducers operating at 40 kc/sec, have now made it economically feasible to apply ultrasonic cleaning to areas measured by the square foot. Up to now, cost and technical problems have largely confined the benefits of this fast and efficient technique to relatively small units.

The large, uniform radiating surface of the transducers makes them particularly suitable for the removal of buffing compounds, radioactive contamination, soldering flux, plaster, carbon smut, etc. The transducers can also be used for other processes such as quenching, plating, pickling, descaling and dyeing. The cleaning action penetrates deeply into blind holes and other areas difficult or impossible to clean by conventional methods.

The Branson LF-15 Transducers have a radiating surface 2⅝"x6", with thick barium-titanate driving elements that transmit the energy through the top of the stainless-steel housing directly into the cleaning solvent. The modular design of the transducers facilitates a wide choice of flush and focused arrangements of transducers.

Generator-Transducers combinations are available with radiating areas from ¼ to 10 square feet:

SONOGEN® MODEL	TRANSDUCER CLEANING AREA
AP-25	¼ Sq. Ft.
APT-100	1
APT-400	4
P-1000	10

Cost of complete equipment, per square inch of radiating surface, ranges from $23 down to $14. We will be happy to send you complete information on request.

BRANSON ULTRASONIC CO.
Division of Branson Instruments Inc.
3 BROWN HOUSE ROAD
STAMFORD, CONN.

For more information circle **160** on inquiry card.

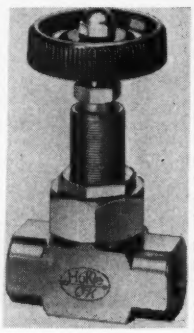
NEW INSTRUMENTS

threaded end is screwed into valve port, it is welded for a permanent joint, leaving other end of adapter providing new straight thread mounting boss.—*Tube & Hose Fittings Div., Parker Appliance Co.*, 17325 *Euclid Ave, Cleveland* 12, *Ohio.*

For more information circle **456** on inquiry card.

VALVES, etc.

VALVE FOR PILOT PLANTS

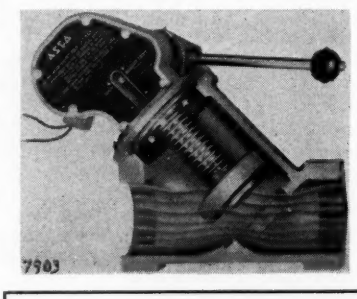


New stainless-steel union-bonnet globe needle valve, designed specifically to solve problems of pilot plant designers, features interchangeability of parts and body styles. A stock valve can be modified by user to meet conditions from vacuum to high pressure, distilled water to corrosive fluids. Sizes from ¼" to ½".—*Hoke Inc.*, 148 *S. Dean St., Englewood, N. J.*

For more information circle **457** on inquiry card.

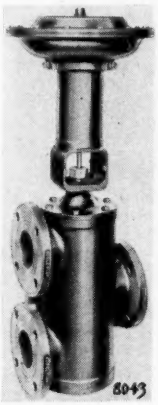
SAFETY SHUT-OFF VALVE

New "Bulletin 8022" safety shut-off manual-reset solenoid valve shuts off fuel automatically and instantly upon failure of power. 1¼" to 3" sizes are approved by Factory Mutual; are designed to control gases in a maximum ambient of 104°F; can be used also to handle fuel oil and non-corrosive liquids. Sizes from ¾" to 6" ips; pressures from 25 to 100 psi.—*Automatic Switch Co.*, 391 *Lakeside Ave., Orange, N. J.*



For more information circle **458** on inquiry card.

BY-PASS VALVES

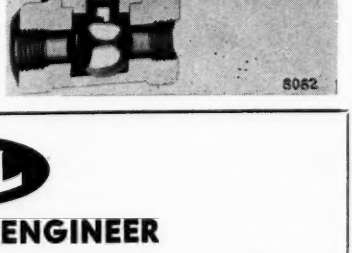


New line of three-way by-pass valves for accurate control of liquid flow features constant total capacity regardless of position of inner valve. Flow can be directed to either of two outlets. Tight-closing feature makes new valves "ideal for diverting applications which would ordinarily require the use of two separate valves." Simple maintenance: change discs and seat rings without removing valve from pipe line. Available in 2½", 3" and 4" sizes; other sizes shortly. Proportional or two-position control.—*Johnson Service Co., Milwaukee* 1, *Wis.*

For more information circle **459** on inquiry card.

BALL VALVE

New ball valve is said to be "the first on the market to incorporate both the Top-Entry (for easy in-line



C-I-L

INSTRUMENT ENGINEER

Our Plastics Division has an opening for an instrument engineer to work on the design and maintenance of instrument circuits and arrangements. Location would be the Division's polythene plant at Edmonton, Alta.

Preference will be given to graduates in physics or engineering having experience with pneumatic and electronic instruments.

Inquiries may be addressed to:

Personnel Office
Canadian Industries Limited
P.O. Box 10, Montreal

maintenance) and Twin-Seal (for positive shut-off with flow from either direction)." Round opening in ball allows piping to handle fluids with minimum turbulence in line. Another feature is wiping action on both sides of ball. Replacement of seat rings can be accomplished quickly and easily without removing valve from line.—*Worcester Valve Co., Inc., Worcester, Mass.*

For more information circle **460** on inquiry card.

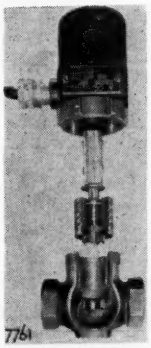
VALVES FOR PILOT PLANTS

7897

New "Series 800" valves have diaphragm operators for on-off or 3-15-lb control, air to open, or air to close. Bodies are bar-stock with screwed ends, straight-through or angle, removable seats and spline plug. Ratings to 15,000 psi. Flow control is governed by shape of grooves or slots milled into plug surface. Parabolic plugs with removable seats are also available. C_v 0.0001 to C_v 2.5 with spline plug and removable seat. Sizes: ¼" to 1".—*Uniflow Valve Corp.*, 19 *Quine St., Cranford, N. J.*

For more information circle **461** on inquiry card.

SOLENOID VALVES

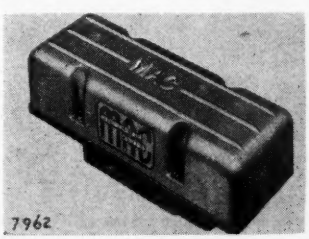

7761

New solenoid valves feature a removable operating assembly to facilitate inspection and cleaning or complete replacement of operating parts without disturbing electrical connection (if flexible conduit is used), and while valve body remains in pipe line. Disassembly can be completed in three simple steps.—*The Magnatrol Valve Corp., 72 Fifth Ave., Hawthorne, N. J.*

For more information circle **462** on inquiry card.

FOUR-WAY AIR VALVES

New "Models 1013 and 1023" 3-position 4-way double-solenoid air valves feature a neutral position and are


7962

MODEL "M" SERIES

Marksman tubeless electronic potentiometer strip chart RECORDER for recording and controlling such variables as temperature, speed, strain, pH and many others.

- No vacuum tubes. Sensitivity of 5 micro-volts or less.
- Potentiometer for thermocouple (TCB protected) or radiation pickup, Wheatstone bridge for resistance pickup.
- Full selection of standard scale ranges . . . 11" calibrated chart width.
- Selector knob changes chart speed . . . 5 speeds per unit without gear change.
- Single or multi-record units available.
- Equipped for 115 or 230 volts — no transformers needed.
- Additional features: Automatic standardization . . . cold junction compensation for thermocouple use . . . battery condition indicator for potentiometer . . . built-in chart saver . . . designed for standard 19" relay rack.

WEST *Instrument* **CORPORATION**
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NOW you can have all these practical advantages in a single instrument. Write for Bulletin M.

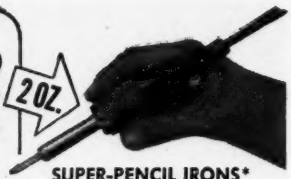
the trend is to **WEST**

For more information circle **161** on inquiry card.

Now you can
solder as easy as you write!
—with
HEXACON
INSTRUMENT
SOLDERING IRONS
—for fast soldering and long life on constant duty

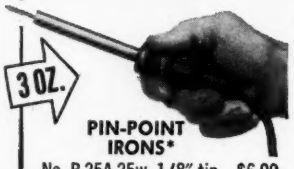
Because of new efficient design, these tiny tips out-perform irons with larger tips and higher wattages. HEXACON offers a new standard in soldering iron efficiency for every conceivable need in the soldering of miniature assemblies.

Send for new circular No. 127 giving more details and comparative competitive performance data.



SUPER-PENCIL IRONS*
No. 25S 25w. 1/8" tip $6.00
No. 26S 30w. 3/16" tip $6.00

BANTAMWEIGHT HATCHET IRONS*
No. 25H 25w. 1/8" tip $6.50
No. 26H 30w. 3/16" tip $6.50



PIN-POINT IRONS*
No. P-25A 25w. 1/8" tip $6.00
No. P-26 30w. 3/16" tip $6.00

Also available in higher wattages

INDUSTRY'S No. 1 HEXACON SOLDERING IRON

HEXACON ELECTRIC COMPANY
506 West Clay Ave., Roselle Park, New Jersey

For more information circle **162** on inquiry card.

Electro-Pulse

PULSE INSTRUMENTATION

- PULSE GENERATORS
- TIME DELAY GENERATORS
- PULSE CODE GENERATORS
- MAGNETIC CORE TESTING EQUIPMENT
- BLOCK UNITS FOR TEST SYSTEMS

VERSATILE... ...WIDE RANGE...ACCURATE...SERVICEABLE

Utilizing advanced circuitry, Electro-Pulse offers a broad line of proven equipment for applications in development and test of RADAR, navigational aids, digital computers, data handling equipment, fire control systems, guided missile control, ballistics research, etc.

MEGACYCLE PULSE GENERATOR
MODEL 3450A
20 CPS to 2 Megacycles
0.1 to 5 μs pulse width
0.1 to 5 μs pulse delay
50 volt low impedance output

Representatives in Major Cities

Electro-Pulse, Inc.

11861 TEALE ST., CULVER CITY, CALIF. • Phone: EXmont 8-6764 or TExas 0-8006

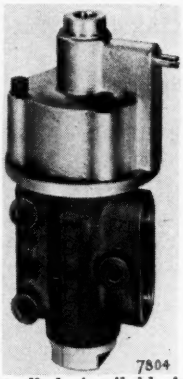
For more information circle **163** on inquiry card.

NEW INSTRUMENTS

available with either open center ("1013") or closed center ("1023"). Available in ⅜" size.—*Mechanical Air Controls, Inc.*, 10030 *Capital, Oak Park, Detroit* 37, *Mich.*

For more information circle **463** on inquiry card.

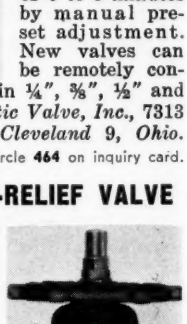
TIME DELAY VALVES



New pilot-operated, 2-way, 3-way and 4-way time delay valves utilize volumetric principle to provide delayed actuation with immediate reversal or immediate actuation and delayed reversal. Operating times of 0 to 5 minutes by manual preset adjustment. New valves can be remotely controlled. Available in ¼", ⅜", ½" and ¾" sizes.—*Airmatic Valve, Inc.*, 7313 *Associated Ave., Cleveland* 9, *Ohio.*

For more information circle **464** on inquiry card.

HP REDUCING-RELIEF VALVE



New "No. 385 Type F" combination pressure-reducing and relief valve for air, gas, oil or water service operates on initial pressures to 4000 psi. Control pressures can be varied by as little as 2 psi over a range as wide as 0-2500 psi. Valve is single-seated, spring-loaded and diaphragm-actuated.—*Atlas Valve Co.*, 280 *South St., Newark* 5, *N. J.*

For more information circle **465** on inquiry card.

H-P HEAVY FUEL OIL VALVE

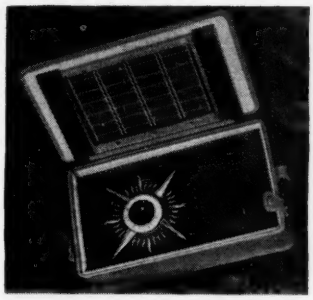
New "HV 44-816" high-pressure heavy-fuel-oil pilot-operated solenoid valve is a packless two-way bronze body valve with full ¾" port and a pressure range of 15 to 300 psi; closes when solenoid is de-energized; is approved by Factory Mutual; features tight shut-off, positive operation, and built-in strainer.—*Automatic Switch Co.*, 391 *Lakeside Ave., Orange, N. J.*

For more information circle **466** on inquiry card.

MISCELLANEOUS

SUN BATTERY

New "Type SB-24B5" converts sun's radiant flux into electric power (illustrated as a power supply for a

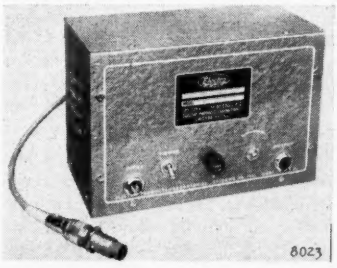


transistorized radio); is said to offer "the greatest economy in milliwatts per dollar of any type of photovoltaic energy converter"—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **467** on inquiry card.

PROXIMITY PICKUP SYSTEMS

New "4950 Series" high-frequency carrier-operated proximity pickup systems can detect presence of metal ob-

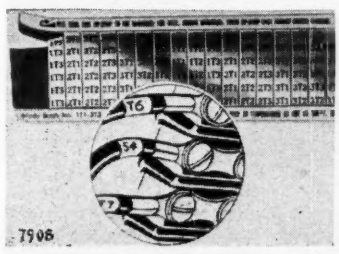


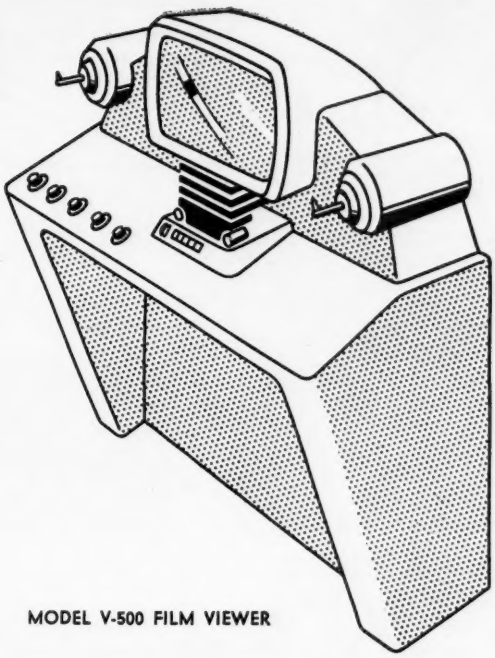
jects at twice the maximum range of maker's "4900" system: up to ¾" away through such nonmetallic substances as plastic, wood, etc., at rates up to 1000 units per second. New systems operate on 115 vac and feature a sensitivity control which adjusts to desired operating ranges and compensates for ambient temperature changes.—*Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **468** on inquiry card.

WIRE MARKERS

New self-sticking aluminum foil metal wire markers feature high resistance to oils and solvents; are thin (3 mils) and conform to wires with-





MODEL V-500 FILM VIEWER

Richardson CAMERA CO

WE SPECIALIZE IN THE DESIGN AND MANUFACTURE OF FILM MOTION EQUIPMENT OF ALL TYPES. WE WELCOME THE UNUSUAL PROJECTS OTHER MANUFACTURERS CAN OR WILL NOT ASSUME.

Richardson CAMERA CO

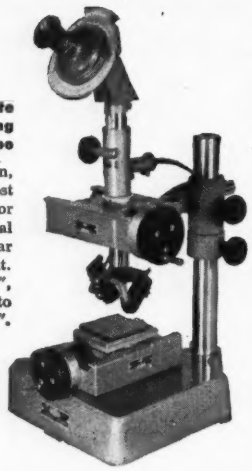
WE BEGAN IN 1936 WITH ANIMATION AND SPECIAL EFFECTS DEVICES FOR THE FILM INDUSTRY. NOW WE LARGELY SERVE INDUSTRY'S ACCELERATED DEMANDS FOR TEST DATA RECORDING AND VIEWING EQUIPMENT.

Richardson CAMERA CO

WE ENTHUSIASTICALLY PURSUE A BUSINESS POLICY OF INTEGRITY AND QUALITY IN EVERY DETAIL. WE TRUST THIS SERVICE APPEALS TO YOU. WE WELCOME YOUR INQUIRIES AND PROBLEMS.

Richardson CAMERA CO
BURBANK CAL

For more information circle **164** on inquiry card.



Coordinate Measuring Microscope

High precision, low cost instrument for 2-dimensional linear measurement. Range 2" x 2", reading to 0.0001".

Cut rejects, speed production

Fast, reliable readings to 0.0001" with Gaertner measuring microscopes

Precise, versatile, easy-to-use Gaertner measuring microscopes assure positive, direct measurement of precision parts. You see clear, sharply-defined images. No physical contact to distort or injure object being measured. Enjoy new production savings with Gaertner optical instrumentation. Write for complete data on the Gaertner line of industrial microscopes.

Toolmakers' Microscope

Ultimate in measuring microscopes. Range 2" x 4", reading to 0.0001", angular measurement to 1 minute.

Micrometer Slide Comparator

Reliable, low cost instrument for linear measurement. Ranges up to 4", reading to 0.0001" or 0.00005".

Filar Micrometer Microscope

High quality, low cost instrument for extremely precise measurements. Range 0.08", reading to 0.00002".

Write for Bulletin 161-54 showing applications, models, specifications.

The Gaertner Scientific Corporation

1211 Wrightwood Ave., Chicago 14, Ill.

Telephone: BUckingham 1-5335

For more information circle **165** on inquiry card.

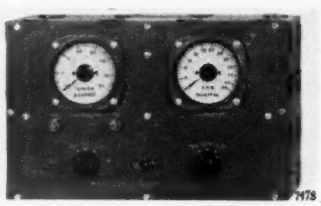
NEW INSTRUMENTS

out bulking; withstand constant operating temperatures up to 375°F; come on handy "Blue Streak" dispenser cards for quick application; have a protective silicone plastic overcoating.—*W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.*

For more information circle **469** on inquiry card.

SPARK PROTRACTOR AND TACHOMETER

New "SAT-300," for measuring spark angle and engine speed of modern automotive engines under road



load conditions, operates directly from a 12 vdc battery system. Scale is graduated from −10° to 60° advance in one-degree divisions. Hand calibration is accurate to 1° over a speed range from 300 to 4800 rpm.—*Photocon Research Products, 421 N. Foothill Blvd., Pasadena 8, Calif.*

For more information circle **470** on inquiry card.

SERVOMOTOR & AMPLIFIER

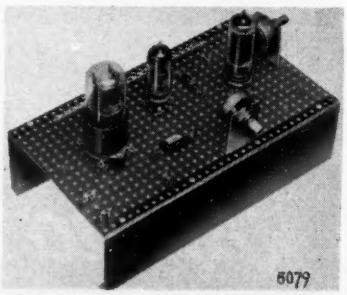
New "Servo Kit," for experimentation and demonstration, comprises one servo amplifier, two servomotors,

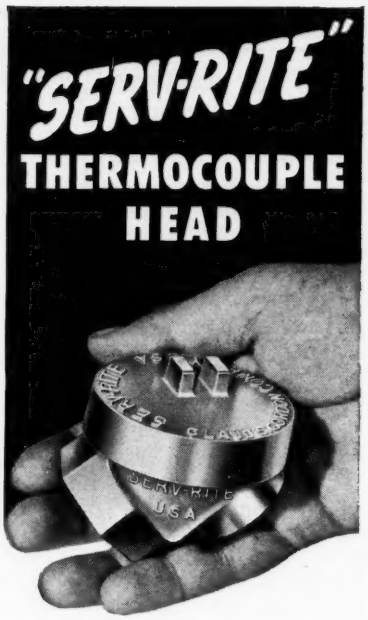
a 2-volume Rider training course ("Basic Synchros and Servomechanisms") and an instruction guide.—*Servo Systems Co., 55 Meeker Avenue, Newark, N. J.*

For more information circle **471** on inquiry card.

EXPERIMENTER'S CHASSIS KIT

New Experimenter's Chassis Kit provides quick set-up of electronic circuitry with simple hand tools; is suitable also for more permanent use





the head that's ahead in every way . . .

This new "Serv-Rite" thermocouple head is actually small enough to be held comfortably in the palm of your hand. But size is only one of the many features that make this thermocouple head really extraordinary. It is loaded with installation and service conveniences that any user of thermocouples will appreciate at once.

The body is of malleable iron, cadmium plated for durability. A new type friction lock assures easy removal or tightening of the cap — a quarter turn does it. An asbestos gasket makes the head dirt- and moisture-proof. With a choice of ½", ¾", or 1" IPS opening for the protecting tube, you can standardize on one style head.

The connector block is of a material especially selected to withstand, without damage, temperatures up to 900° F. in continuous service. Improvements over the conventional type of inserts greatly simplify the making of the lead wire connections. The complete thermocouple element, including connector block, can be easily withdrawn for inspection.

Install a "Serv-Rite" thermocouple head and see for yourself how much better it really is.

Write for complete details

5606

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers · Engineers · Distributors

Thermocouples & Accessories • Temperature Control Instruments • Industrial Furnaces & Ovens Metallurgical Testing Machines

609 West 30th Street, Chicago 16, Illinois
2025 Hamilton Avenue, Cleveland 14, Ohio

For more information circle **166** on inquiry card.

and can be mounted. Decks are 4¾" x 8½" or 4¾" x 17" and are packed with a variety of accessories. Feature: Push-In Terminal whereby, with a wire of any size between 0.030" and 0.045", connections need not be soldered for temporary testing.—*Vector Electronics Co., 3352 San Fernando Rd., Los Angeles 65, Calif.*

For more information circle **472** on inquiry card.

HI-VAC PUMP AND PORT

New "Type 3116-03" stainless-steel high-vacuum pump-and-port assembly, expected to find wide use in evacuation of cathode-ray tubes, has a pumping speed of 5 liters per second at port opening and attains an ultimate pressure of 2×10^{-6} mm Hg. Port accommodates ⅜" or ½" tubulations; is water-cooled; is connected at a right-angle to pump so that broken glass cannot enter pump jet area.—*Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **473** on inquiry card.

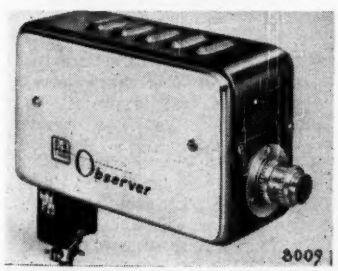
TV CAMERA

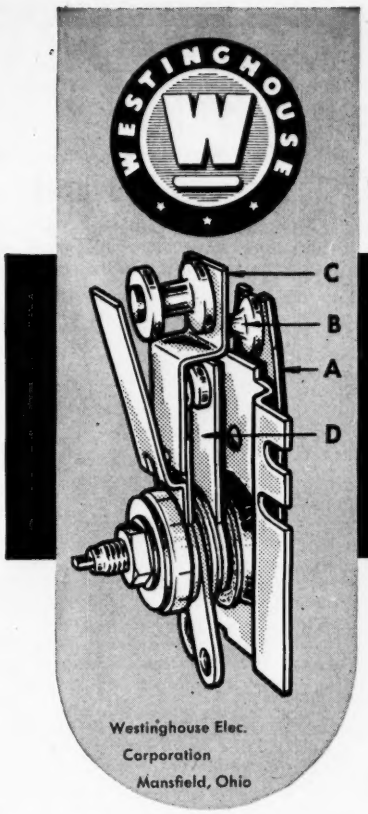
New "Utilicon 600" features extremely high sensitivity, "several times greater than other tubes of its type." Surface characteristics are such as to provide more uniform background shading and black to white contrast. Resolution capability is 600 lines; side tubulation eliminated to permit rotation to obtain maximum horizontal resolution. "600" is readily interchangeable with tubes used in customary industrial TV cameras.—*Electronic Sales Dep't, Diamond Power Specialty Corp., Lancaster, Ohio*

For more information circle **474** on inquiry card.

CLOSED-CIRCUIT TV CAMERA

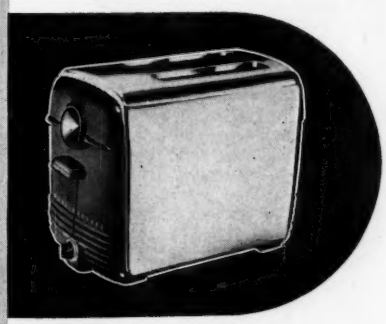
New "Model TVC-1" package, including Vidicon, *f*-1.9 lens, multi-conductor cable and control generator, provides one high-definition video output and two RF outputs for direct connection to standard TV receivers. All outputs can be used simultaneously and several cameras and any number of receivers can be connected in one closed-circuit system. Control generator operates up to 500 ft from camera and output signal carries thru





HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE

WESTINGHOUSE



Pop-Up Toaster

Uniform toasting in just 90 seconds is featured by this new Westinghouse pop-up toaster. A new type of heating element is combined with a reflector on each side of the two slices. Its unique dual element thermostat compensates for variations due to voltage fluctuations and reduced browning of the second and third slices. The controlling elements are accurate, dependable Chace Thermostatic Bimetal, of course.

The operation of the thermostat is ingenious: the right hand bimetal element (A) controls the temperature of the air in the toasting chambers, hence the degree of browning. This highly responsive bimetal is positioned so it is exposed to the radiation from the heating element. High voltage (more heat) makes the element deflect to the left and the ceramic point (B) moves the upper spring-mounted contact arm at (C), opening the circuit, thus preventing over-browning. When voltage drops, the effect is opposite.

The left hand bimetal element (D) controls browning of second and third slices. Being of a much less responsive type, it is gradually deflected to the left by the ambient temperature in the toaster, moving the contact arm (C) and prolonging the period of the circuit.

Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal, formulas, calculations, etc.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

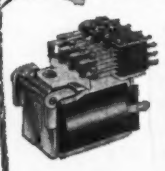
For more information circle **167** on inquiry card.

SWITCH TO AUTOMATIC CONTROL!

With AEMCO

the complete line of relays, timers and time switches

Specialists in the control field for more than 30 years, AEMCO offers you fresh, new ideas . . . ideas that save you money in automatic control . . . ideas that save you valuable time. Your inquiries are invited write for complete information.



RELAYS

At AEMCO we specialize in both the design and manufacture of relays to your mechanical and electrical specifications. Should one of hundreds of stock AEMCO relays fail to meet your specialized requirements exactly, we will be happy to build a unit not only to meet, but to exceed those specifications.

INDUSTRIAL TIME CONTROLS

Now control that vital operation automatically! Available in many different models with automatic or manual re-set, AEMCO industrial time controls help eliminate waste . . . help speed up production. Variations are available on standard cycling models . . . dials are easy to read, easy to set.

Write Today

For detailed information on AEMCO Relays or the complete AEMCO Industrial Time Control line.

AEMCO INCORPORATED

60 State Street • Mankato, Minn.

For more information circle **168** on inquiry card.

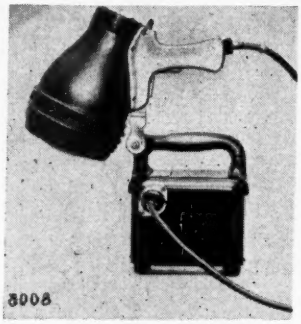
NEW INSTRUMENTS

2000 ft of RG-11/U cable before line amplifiers are inserted.—*Blonder-Tongue Labs, Inc.*, 526-536 *North Ave., Westfield, N. J.*

For more information circle **475** on inquiry card.

ULTRAVIOLET SOURCE

New "Blak-Ray Model B-100" provides long wave ultraviolet radiation for chromatography, lab research, in-

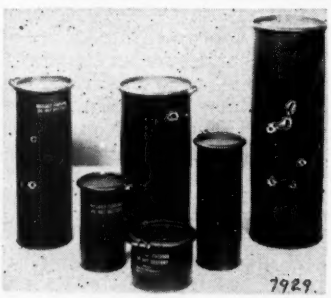


spection and medical observation; is a concentrated source of 3660-Angstrom radiation readily adaptable to any task. Lamp head is attached to base through a spring-tension arm which allows uv beam to be rotated 180° but can be slipped from base and held in hand by pistol-grip handle.—*Black Light Corp. of America, San Gabriel, Calif.*

For more information circle **476** on inquiry card.

RE-USABLE SHIPPING CONTAINERS

New re-usable shipping containers in a wide range of "non-standard" body heights offer substantial savings



by eliminating interior cushioning, exterior crating and shipping space.—*George D. Ellis & Sons, Inc., American & Luzerne Sts., Philadelphia 40, Pa.*

For more information circle **477** on inquiry card.

LIQUID-LEVEL GAGE GLASS CLEANING ROD

New cleaning rod really gets the inside of liquid-level gage glasses clean; does not employ a brush. A tubular cloth swab is slipped over a piece of corrosion-resistant spring steel on end of rod. A detergent or other cleaning medium is applied to swab; rod is then inserted into end

compare this

PINCH-TYPE VALVE

* $85.50 F.O.B. Our Plant. Standard Series "R" Pinch-Type Valve, 1½", Air-To-Close, 100 PSI Pure Gum Rubber Body.

ON QUALITY ALONE...

ON COST ALONE*

No matter how you compare an RKL pneumatically - operated pinch valve . . . it always comes out on top. Check these exclusive features and you'll see why.

- **Rolling diaphragm air motor . . . proven in millions of tough applications . . . unmatched for positioning accuracy and linearity.**
- **Stainless steel stem and guide rods . . . resist corrosion and wear.**
- **Solid cast aluminum alloy frame . . . light weight combined with high mechanical strength.**
- **Pinch limit stops . . . prevent over-pinch regardless of air pressure . . . longer body life . . . no accidental failures.**
- **Completely self-supporting . . . never any need to give an RKL valve extra support.**

SPECIFICATIONS IN BRIEF

PIPE SIZE: All standard pipe sizes, ¼" to 14".

TYPES: Air-to-open, air-to close, quick-acting hand lever operated, handwheel operated, solenoid operated, hydraulically operated.

CONNECTIONS: Flanged or slide-on.

BODY MATERIAL: Pure gum rubber is standard. Teflon, polyethylene, other rubbers available.

DIMENSIONS AND WEIGHT: 1½" valve illustrated above measures approximately 11½ x 6 x 12 and weighs just less than 14 pounds.

BULLETIN 1154 gives a complete description of RKL pinch valves, applications, body materials, capacities, etc. . . . *a handy reference guide that's yours on request.*

RKL VALVE & MANUFACTURING CO.
ROUTE 38 & RUDDEROW AVE.
MAPLE SHADE, NEW JERSEY

For more information circle **169** on inquiry card.

connection of gage (or drain in offset of valve). When swab is visible in glass, simply pull back handle and tighten thumbscrew: result is an increased arc of spring, forcing swab against glass. Standard length 36"; longer lengths on order.—*Jerguson Gage & Valve Co.*, 80 *Fellsway, Somerville* 45, *Mass.*

For more information circle **478** on inquiry card.

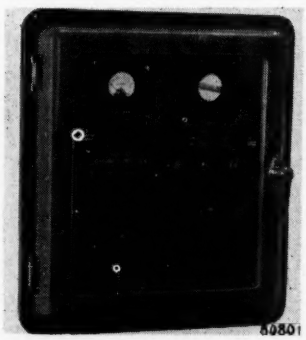
DEMODULATOR

New "Series 6101 D" supplies differential transformers and converts their output to dc for use with micrometers, recording potentiometers, etc.; can be located up to 1000 ft from transmitter (on 4-wire cable) and several thousand ft (on 2-wire dc); features stability of better than ¼% with line variation of 10%. Calibrating circuit permits testing at any time without disturbing transmitting device. No vacuum tubes or choppers are used: only magnetic and semiconductor devices of highest quality.—*Automatic Temperature Control Co., Inc.*, 5200 *Pulaski Ave., Philadelphia* 44, *Pa.*

For more information circle **479** on inquiry card.

CHLORINE DETECTOR

New "Series A-689 Solvay Chlorine Detector" monitors a continuous controlled sample of air, warning when



chlorine concentrations in the air exceed 3 parts per million; thus gives a warning long before a concentration of 15 ppm is present that would cause throat irritation. Made for either wall or panel mounting.—*Wallace & Tiernan Inc.*, 25 *Main St., Belleville* 9, *N. J.*

For more information circle **480** on inquiry card.

CORRECTION

In item on "Series 185" pressure transmitter of Manning, Maxwell & Moore (August issue, page 1580) repeatability should be "0.0002" or "0.02%" but not "0.0002%."

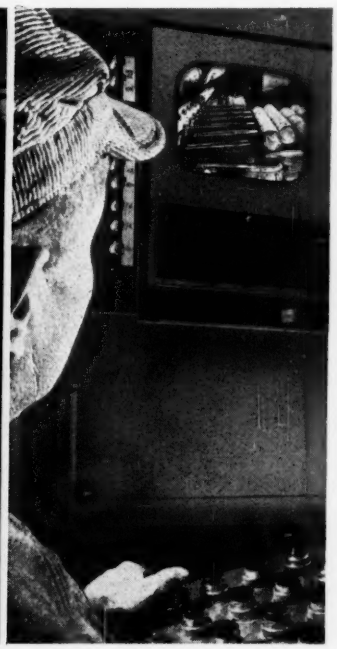
TIMKEN Company

ORDERS 2 MORE DIAMOND ITV UNITS

(WIRED TELEVISION)

AFTER 3 SUCCESSFUL INSTALLATIONS

Picture of furnace interior on Diamond ITV viewing screen is watched by remote dispatcher. A flip of a switch and he SEES conditions in another furnace on same screen.

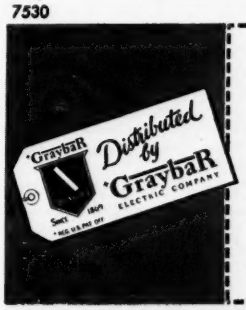


Operator at another control pulpit SEES a visually inaccessible billet loading area for a pusher type furnace.

The Timken Roller Bearing Company made its first application of Diamond Industrial TV in August 1951 for remote observation of the interior of a tube-cooling furnace. Since that time two additional installations have been made to watch (1) the inside of another furnace and (2) the remote handling of billets by a crane. The success of these has resulted in a recent order for two more sets of Diamond ITV.

You, too, probably can use Diamond ITV to substantial advantage. Call your Graybar Distributor or use the coupon below.

7530



DIAMOND POWER SPECIALTY CORP.
"FIRST IN INDUSTRIAL TELEVISION"
ELECTRONICS DEPT., P.O. BOX 56MM
LANCASTER, OHIO

Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

Name_____

Title_____

Company_____

Address_____

For more information circle **170** on inquiry card.

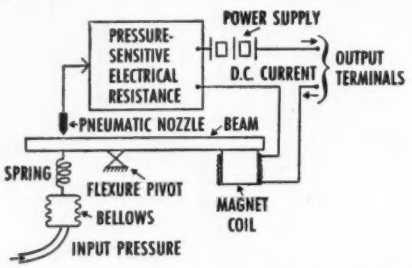
INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

P-E-P

P-E-P is new . . . the Pneumatic-Electric-Pneumatic Transmission system that converts all process variables to a direct current for simple transmission, and reconverts to a pneumatic output, without tubes or complex circuitry. It converts the output of any transducer to a signal of 3-15 milliamperes for transmission electrically. The receiver converts the DC signal to pneumatic pressure of 3-15 PSI for actuating valves or other equipment.

When used with a pneumatic or mechanical transducer (see illustration) the P-E-P System balances forces on a

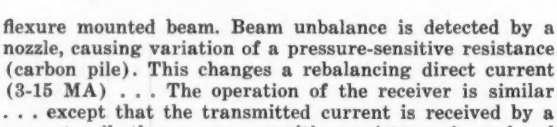


flexure mounted beam. Beam unbalance is detected by a nozzle, causing variation of a pressure-sensitive resistance (carbon pile). This changes a rebalancing direct current (3-15 MA) . . . The operation of the receiver is similar . . . except that the transmitted current is received by a magnet coil, the pressure-sensitive resistance is replaced with a pneumatic pilot valve, and the output pressure is fed back to the bellows to rebalance the beam. (*From new 2-page brochure announcing this new electrical transmission system for pneumatic systems, Robertshaw-Fulton Controls Co., Fielden Div.,* 2920 *N.* 4 *St., Phila.* 33, *Pa.*)

For this literature circle **501** on inquiry card.

Programming Analog Computers

The operational equation of a circuit may be defined as an equation which relates the output to the input in terms of the mathematical operation performed by the circuit on the input . . . Electronic computers are char-

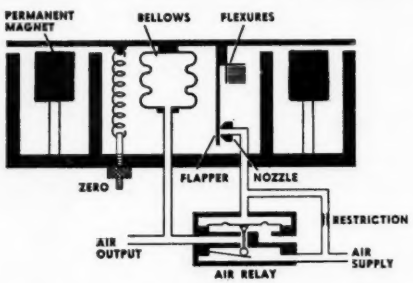


acterized by their ability to perform certain mathematical operations electronically. Whereas addition and subtraction are the basic operations of digital computers, analog computers can perform these and a variety of others such as integration, multiplication, differentiation, etc., in their repertoire of basic operations. Also, just as integration and multiplication are composite operations in digital computers, electronic analog computers perform composite operations by combining several or all of the basic ones. This is the underlying principle of their use, and rules may be easily established to find the necessary combination for solving a given problem . . . (*From new 12-page Data File* 120, *Berkeley Div. of Beckman Instruments, Inc.,* 2200 *Wright Ave., Richmond* 3, *Calif.*)

For this literature circle **502** on inquiry card.

EMF/Pneumatic Transmitter

The EMF/Pneumatic Transmitter converts a d-c millivoltage measurement of temperature, speed, pH and many other variables to a proportional 3-15 psi pneumatic output signal . . . Receives a millivolt signal from the meas-



uring element (thermocouple, tachometer, etc.), converts it by means of the magnettor circuit into a proportional 2000 cps a-c voltage, amplifies and filters the signal, and feeds it to a phase detector circuit. The resulting d-c output is passed through a temperature-stable resistor (R) and a transducer winding, connected in series.

Heart of the Transmitter is the transducer shown schematically . . . Standard Transmitters are available for measurement spans as narrow as 5 millivolts or as wide as 60 millivolts . . . (*From new 4-page Bulletin* 20-16, *The Foxboro Company, Foxboro, Mass.*)

For this literature circle **503** on inquiry card.

Conversion Tables

To convert ampere turns into Gilberts multiply by 1.257; to convert inches of mercury at O°C into oz. per

ELECTRICAL QUANTITIES

Quantity	Symbol	Defining Equation	Units
Admittance	Y	$Y = I/U$	mho
Attenuation constant	α	$\alpha = \frac{1}{x} \ln \frac{E_0}{E}$	neper
Capacitance	C	$C = Q/U$	farad
Complex dielectric constant	ϵ°	$\epsilon^\circ = \epsilon' - j\epsilon''$	farad/m
Complex index of refraction	n°	$n^\circ = n(1 - jk)$	
Complex permeability	μ°	$\mu^\circ = \mu' - j\mu''$	henry/m

sq. inch, multiply by 0.5782. (*From new* 28 *x* 22 *inch wall chart with temperature conversion tables, decimal equivalents, electrical quantities, wire sizes for motor circuits, conversion tables, etc, Perkins Engineering Corp.,* 345 *Kansas St., El Segundo, Calif.*)

For this literature circle **504** on inquiry card.

Third International
AUTOMATION
Exposition
NOVEMBER 26-30
New York Trade Show Building
500 Eighth Avenue, N.Y.C.
"the show of the future"

LARGEST STOCK OF RELAYS IN THE WORLD

PRODUCTION QUANTITIES IN STOCK • FAST DELIVERY FROM OUR STOCK

WESTON Model 705 SENSITROL

#R561

Stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact which draws movable contact and holds it firmly. Contacts remain closed until reset. Will operate directly from a photocell or a group of thermocouples. Net weight 14 oz.

Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts; "Twintacts", Capacity 100 ma at 110 volts; Nickel plated brass cover; Weston Model 705 Type 6 #R560 ..**18.75*** Same as #R560 but with glass face; Weston Model 705 Type 6 #R561 **19.75*** Single contact (Normally Open), Solenoid Reset; Sensitivity; 10 Microamperes; Reset coil; 6-24 V DC or 24 V AC; Contact: "Twintact", capacity 100 ma at 110 volts; Glass Face; Weston Model 705 Type 4 #R523 .....**17.75*** Same as #523 with Brass Cover Weston Model 705 Type 4 #R523N **16.75***

STEPPING SWITCHES

SS5 Mfd. by Western Electric Minor Switch 10 steps and off Contacts: #'s R960, 975, 976 **Gold** plated brass; Bridging Wiper; others non-bridging; Net. Wt. 1 lb.

Step & Reset	Each*
#R960; Single Level; 6 to 12 VDC	9.50
#R975; Single Level; 24 to 36 VDC	10.50
#R976; Single Level; 48 to 60 VDC	11.50
#R643; Single Level; 100 to 125 VDC	12.50
#R977; Two Level; 6 to 12 VDC	10.50
#R978; Two Level; 24 to 36 VDC	11.50
#R979; Two Level; 48 to 60 VDC	12.50
#R644; Two Level; 100 to 125 VDC	13.50
#R642; Three Level; 6 to 12 VDC	11.50
#R600; Three Level; 24 to 36 VDC	12.50
#R645; Three Level; 48 to 60 VDC	13.50
#646; Three Level; 100 to 125 VDC	14.50

SS6 Mfd. by Western Electric Co.; 22 step; 5 levels; Bridging Wipers; Contacts; Gold plated brass. Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz.

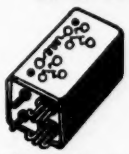
"Homing" Type; 180° Wipers; Step in One Direction	Each*
#R926; 6 to 12 VDC	13.75
#R980; 24 to 36 VDC	14.75
#R981; 48 to 60 VDC	15.75
#R615; 90 to 120 VDC	16.75

SS7 Mfd. by Western Electric Co.; 44 step; 2 Levels; Bridging Wipers; Contacts: Gold plated brass; Interrupter Switch; 1 Break-Make; Net Weight 1 lb. 14 oz.

"Homing" Type; 360° Wipers; Step in One Direction	Each*
#R927; 6 to 12 VDC	13.75
#R982; 24 to 36 VDC	14.75
#R983; 48 to 60 VDC	15.75
#R616; 90 to 120 VDC	16.75

CLARE TYPE 20 "Homing" type; Step in one direction; 20 position; 180° wipers, one bridging and remainder non-bridging; Interrupter Switch: 1 break. #R891; 24-36VDC; 3 levels; Clare #SD19 **12.95 each**

LATEST HERMETICALLY SEALED SUBMINIATURE TYPES SIGMA 22RJ SP & DP SENSITIVE TYPES



Light weight; Extremely small; Hermetically sealed in solder dipped brass can; 3 oz max weight. Silver contacts rated at 2 amp; solder lug connections.

22RJA200G: 10.0 ma operate, 3.5 ma release; 1A; 200 ohm; #R618 ..... **7.50* ea**
22RJCC5000G: 2.8 ma operate, 1.0 ma release; 2C; 5000 ohm; #R619 ..... **9.50 ea**
22RJCC8000G: 2.3 ma operate, 0.8 ma release; 2C; 8000 ohm; #R617 ..... **9.50* ea**

ALLIED 50G MH MULTIPOLE TYPES

Developed to meet spec MIL-R-575A; 18-30VDC; Hermetically sealed; −55°C to +85°C; 50G for 11 milliseconds. Contact rating 2 amp. Solder lug connections.

MH18DT: 26.5 VDC; 6PDT (6C); 240 ohm; 4.2 oz; Operate time: 8 millisec, release: 5 millisec. Mounting plate opposite terminals; #R647 ..... **7.50* ea**
MH18D: Same as R647 above but mounting plate on same side as terminals (As illustrated); #R648 ..... **7.50* ea**
MH12D: 26.5 VDC; 4PDT (4C); 300 ohm; 2.9 oz; Operate time: 7 millisec, release: 5 millisec; #R649 ..... **7.00 ea**
MH6D: 26.5 VDC; DPDT (2C); 400 ohm; 1.2 oz; Operate time: 6 millisec, release: 5 millisec; #R665 ..... **6.00 ea**
STRUTHERS DUNN 220XFX100; (Similar to Allied MH18D); 26.5 VDC; 6PDT(6C); 240 ohm; 3 oz; #R1145 ..... **7.50* ea**

FILTORS, INC.

Developed to meet spec MIL-R-5757B; 4 to 9 VDC. Hermetically sealed; −65°C to +125°C; 50G for 11 millisec; contact rating 3 amp. Solder lug connections.

6C9A: 6.3 VDC; 3PDT(3C); 42 ohm; 2.6 oz; #R669 ..... **6.50 ea***
26SA12A: Developed to meet spec MIL-R-575A; same as Allied MH12D; 26.5VDC; 4PDT(4C); 250 ohm; 2.2 oz; solder lug header; #R670 ..... **7.00 ea***

*Prices shown with asterisk (*) are subject to quantity discounts listed above.

We are Exhibiting at Booth 121

Prices listed with asterisk (*) are subject to QUANTITY DISCOUNTS		
	1-9	as quoted
	10-49	10%
	50-99	15%
	over 100	20%

ADVANCE F & S SERIES

Light weight; compact; versatile relays for multitude of applications.

F2A C8726-1; 9.5VDC; SPDT(1C); 200 ohms; Solder lug header; #R666 .....**5.95 ea**
F2A C8727-1; 18-30VDC; DPDT(2C); 500 ohm; Solder lug header; #R664 .... **5.95 ea**
S2A D8701-1; 48VDC; DPDT(2C); 2000 ohms; Solder lug header; #R667 .... **5.95 ea**
S2A C8720-1K; 28VDC; SPDT(1C); 500 ohms; Solder lug header; #R668 .... **5.95 ea**

POTTER BRUMFIELD

SM5LS; 3 ma; SPDT(1C); 10,000 ohm; ¾" Dia x 1¾" H. Fits standard 7-pin miniature tube socket; #R1008 .... **3.95 ea**

MAGNETIC CLUTCH

Double acting magnetic clutch; rated for operation on 24VDC; 125 ohms; 200 ma. Pulls in at 18 VDC, drops out at 5 VDC. Tooth clutch assures positive coupling. Torque capacity 12 in-lbs. An extra output shaft and a concentric flange are engaged with power off. When power is applied, flange disengages and shaft can rotate freely while coupling engages shafts through the unit. Flange can thus be used as a quick acting brake on output shaft.

Of ball-bearing construction, can operate at high speed. Suited for precision use as backlash and play are zero. Stainless steel output shaft 3/16 dia. x ½" long. Bronze input shaft 5/16 dia. x ⅜" long. Concentric flange, 1⅝ dia. x 3/16" thick with 3 equally spaced tapped holes for coupling. Aluminum body 1⅞ dia. x 2" long, exclusive of shafts. Mounting flange at output end. Shipping Wt., each 5 lb.

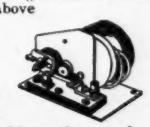
#MC101 ..... **6.50* ea**

GEARS

Bronze Gear For Input Shaft 1⅝D 80 teeth #G101 **.35* ea**
Bronze Gear For Flange 3¼D 144 teeth #G102 **.60* ea**
Stainless Steel Gear For Output Shaft 1"D 48 teeth #G103 **.30* ea**

*See quantity discounts above

KURMAN TIME DELAY



R-308, motor driven 110 V 60 cycles; continuously adjustable delay 10 to 60 seconds; SPST (1A); #R671 **7.95* ea**

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT.

SEND FOR LATEST CIRCULAR. TERMS:—All Prices F.O.B. Our Plant Rated Firms Net 10 Days; All Others Remittance with Order. Orders Under $10.00 Remittance with Order, Plus Approximate Shipping Charges (Overage Will be Returned).

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Universal general corp.

For more information circle **171** on inquiry card.

TIME YOUR TESTS IN SPLIT-SECONDS!

GRA-LAB

ALL PURPOSE LABORATORY TIMERS

MODELS AT $21.95 TO $26.95

You can set the large 8" dial for any desired time period within an unusually wide range of 3600 possible settings, (ie., 1 sec. to 60 min., 1 min. to 60 hrs., etc.). At end of preset interval, alarm sounds and external load is automatically switched on or off.

Gra-Lab Micro Timers, **Electric Stop Clocks,** are available in 1/10 sec. or 1/1000 min. graduations for split-second measurements of elapsed time in laboratory or production operations. Price $37.50

WRITE FOR COMPLETE CATALOG!

DIMCO-GRAY COMPANY

212 E. Sixth St.
DAYTON 2, OHIO

For more information circle **172** on inquiry card.

cleaned and back at work in 5 minutes

Waukee FLO·METER

The Waukee FLO-METER can be cleaned and back in operation in five minutes *or less!* Saves time and money.

Inherent accuracy of the FLO-METER is protected by Waukee's design for fast, easy cleaning. No tools are needed. Production interruption at a minimum.

The Waukee FLO-METER also features: built-in Control Valves, panel mounting, simple piping, large 6" and 9" scales for ease of reading. Capacities 3 CFH to 10,000 CFH.

Complete information in Bulletin 203. Write for it. **Waukee Engineering Company,** 5137 North 35th Street, Milwaukee 9, Wisconsin.

For measuring: air — ammonia — dissociated ammonia — argon — butane — city gas — endothermic cracked — exothermic cracked — forming gas — helium — hydrogen — natural gas — nitrogen — oxygen — propane.

Waukee FLO-METERS • AIR-GAS MIXORS
INDUSTRIAL WASHING MACHINES

For more information circle **173** on inquiry card.

BRIEFS—CONTINUED

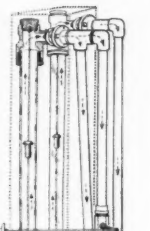
Gravity Anomaly Simulator

Mathematically, using Lambert's cosine law, it may be shown that the light integral for a horizontal layer has the same form as the gravitational integral for the same layer. By suitably scaling down all dimensions of the layer in the gravitational case, we can form a luminous surface of the same shape and perform the integration by simply measuring the illumination . . . An opaque slide of paper having an opening in the outline of the desired body is placed over a light source. The light reading is shown on a meter and combined with a multiplicative factor in determining the gravitational anomaly . . . (*From new 2-page Bulletin No. GM-203, Houston Technical Laboratories, 2424 Branard, Houston 6, Texas.*)

For this literature circle **505** on inquiry card.

Multi-Stage Flowrator Meter

The F&P Figure 164 Multi-Stage Flowrator Meter is a high-accuracy, wide range, variable-area flowmeter. It has been designed for precise flow measurement and evaluation of aircraft and automotive components . . . Flow measurement of from 5 to 100,000 pounds per hour is accomplished with a low pressure loss and an accuracy of ±½ of 1% of flow rate . . . (*From new 8-page Catalog 10-A-34, Fischer & Porter Co., Hatboro, Pa.*)



For this literature circle **506** on inquiry card.

INSTRUMENTATION ENGINEER

There are a few select positions in General Electric's Small Aircraft Engine Department for well qualified engineers who are at home in the areas of instrumentation development. At the same time they must be able to take the initiative in developing new and higher standards.

A thorough knowledge of laboratory experimentation instruments is required and the ability to apply these in measuring aerodynamic flow, vibration, etc. One activity involves the development of general instrumentation; the other is the application of instruments to the testing of engines and engine components.

Work is in advanced areas where individual achievement is quickly recognized and rewarded. Starting salaries are high and are coupled with an outstanding benefits program. The location near Boston is well known as a cultural center.

For futher information write, giving details of education and experience in confidence to:

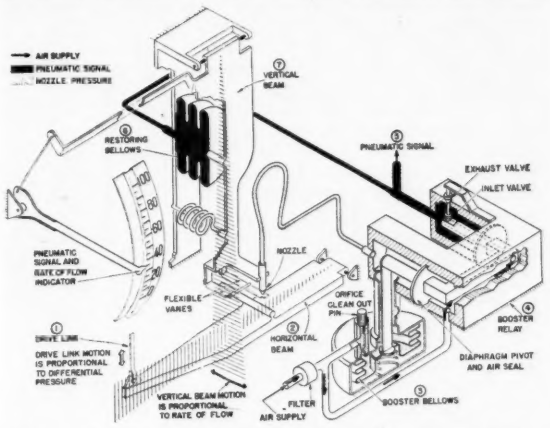
Mr. T. S. Woerz (Section 6-B)
SMALL AIRCRAFT ENGINE DEPARTMENT

GENERAL ELECTRIC

1000 Western Avenue, West Lynn, Mass.

Flow Transmitter

The Bailey Flow Transmitter extracts the square root of flow differential measurements to produce a pneumatic signal proportional to rate of flow; transmits to indicating, recording, integrating, and/or controlling equipment at remote stations . . . For the measurement and trans-



mission of rate of flow of liquids and gases producing standard differential pressure ranges from 0-50 to 0-1200 in. H_2O under service pressures from 800 to 6000 psig.

Input link (1) moves horizontal beam (2). Resulting change in vane-nozzle relationship causes change in booster bellows (3), thus activating booster relay (4), Pneumatic signal (5) produced by booster relay is also applied to restoring bellows (6) to reposition vertical beam (7) to restore original vane-nozzle relationship . . . (*From new 6-page Product Specification P22-6, Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*)

For this literature circle **507** on inquiry card.

What do you want to know about
AUTOMATIC PRODUCTION, ASSEMBLY, CLEANING AND FABRICATION?

You can learn about . . .

Automatic work positioning, drilling, machining—a frontier of automation—learn how to apply it to your machine tools.
Presented by Hillyer Instrument Co., in Room 520

"Digimatic" control systems for machine tools—featuring tape-recorded control data.
Presented by Electronic Control Systems, Inc., in Room 507

Special and standard gaging and control systems and components for machine tools.
Presented by Airborne Instruments Labs., in Room 302

Automatic transfer machines, conveying equipment and automatic production machines.
Presented by Aard Equipment Company, in Room 405

COC (Centralized Operations Control) systems built up from COC subsystem elements—many practical examples.
Presented by Hammarlund Manufacturing Co., in Room 551

Automatic transfer and conveying equipment—automatic warehousing.
Presented by Gaudreau-Rimbach Associates, in Room 409

Work center systems for efficient production and assembly.
Presented by Alden Systems Company, in Room 321

Dust control for precision assembly—sterile atmospheres.
Presented by Baker Company, Inc., in Room 408

Ultrasonic techniques for cleaning, gaging, inspection.
Presented by Branson Ultrasonic Corp., in Room 548

Component cleaning—with live demonstrations of automatic cleaning equipment.
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Automatic control units for positioning of machine tools with tape, card or pre-set programming.
Presented by Warner & Swasey Research Corp., in Room 443

at the **CLINIC FOR AUTOMATIC PRODUCTION, ASSEMBLY, CLEANING and FABRICATION** at the Third Automation Exposition. See page 1970 for registration coupon.

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Push-Button
SWITCHES

. . . U.L. APPROVED RATING
8—AMPS., 115 volts, ac.

Dress-up instruments, appliances and countless other products with a switch that "feels" and performs like a true Snap-Switch should. Hetherington B-Series push button switches have an exceptionally positive, audible snap action that can't be teased off contact . . . allows full 8-ampere rating in less space than most ½-amp switches. Normally-open or normally-closed SP-ST types available with pigtail leads or lug terminals.

Get complete details. Write for Data Sheet S-4.

Push-button, Rotary, & Toggle Switches
Indicator Lights
Switch-Light combinations

HETHERINGTON INC.
1200 Elmwood Avenue, Sharon Hill, Pa.

For more information circle **174** on inquiry card.

TEST FOR **C** CARBON IN JUST 2 MINUTES

with a DIETERT-DETROIT carbon determinator

Why bother with tedious, time consuming laboratory routines when a Dietert-Detroit Carbon Determinator provides a completely accurate analysis of carbon content in just two minutes. Easy, too . . . no involved computations! Samples may be borings, mill chips, crushed samples, pellets, etc.

Sulfur Determinators also available for performing fast, accurate tests on wide range of materials.

Excellent performance record with:

IRON / STEEL / PETROLEUM CATALYSTS
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Illustrates and describes both Carbon and Sulfur Determinators and accessory equipment.

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9330 ROSELAWN DETROIT 4, MICH.

Send me your latest Carbon-Sulfur Determinator Catalog.

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For more information circle **175** on inquiry card.

NEW HI-VOLUME AIR SAMPLER

accurately samples the air for radioactive material, particulate matter, etc.

Hundreds used in Atomic Energy tests, and by Industries employing, developing and manufacturing nuclear products . . . Literally "inhales" an entire area with unparalleled speed and accuracy . . . Particles as small as 1/100th a micron in diameter have been accurately sampled by this unit . . . Portable . . . Designed for indoor and outdoor use . . . Indispensable for series or unit tests. 24 V, 110 V, & 220 V models available.

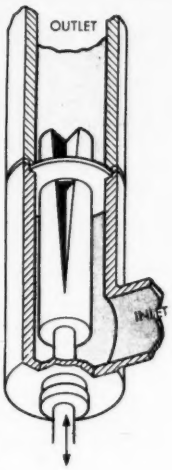
For details about this new scientific method

THE Staplex CO.
AIR SAMPLER DIVISION
784—5th Ave., Brooklyn 32, N. Y.

For more information circle **176** on inquiry card.

BRIEFS—CONTINUED

V-Notch Chlorinator



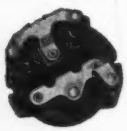
The W&T V-Notch Variable-Orifice is the heart of the control system of the Series A-712 chlorinator. The flow of chlorine gas is adjusted by varying the area of the V-notch Variable-Orifice while maintaining a constant differential across the orifice . . . The V-notch Variable-Orifice control system will maintain the set feed rate within 4% on all flows within the 20 to 1 calibrated range . . . Automatic operation is accomplished by automatically positioning the V-notch plug within the ring to change the size of the V-notch Variable-Orifice in proportion to a control signal. Auxiliary positioning equipment which converts signals from a primary meter, program timer, or step-rate controller is mounted inside the chlorinator housing . . . (*From new 8-page Catalog File No.* 25.110, *Wallace & Tiernan, Inc.,* 25 *Main St., Belleville* 9, *N. J.*)

For this literature circle **508** on inquiry card.

Level Trols

The important point to remember in understanding the operation of the Level-Trol is that the float, regardless of shape or size, must always be heavier than the liquid it displaces . . . The displacement type float provides a most satisfactory method for measuring the level and all that remains is to translate the buoyant force to a

The Finest Electrical Contacts AT THE LOWEST QUANTITY PRICE



AUTOMOBILE SWITCH

APPLIANCE TIMER

D. E. Makepeace, over 50 years a leader in the bonding of precious metals to base metals, offers to the electrical industry a line of quality contacts at mass produced prices for exceptional economy. The raised lay and spot lay contacts illustrated are typical for scores of special applications produced to rigid specifications. We'd like to help you design for outstanding performance with remarkable economy.

SPOT LAY®

RAISED LAY

Makepeace
D. E. MAKEPEACE COMPANY
Division of
Union Plate and Wire Co.
Attleboro, Mass.

ENGELHARD INDUSTRIES

For more information circle **177** on inquiry card.

MARSH MAKES IT!

If it's a pressure gauge or dial thermometer, Marsh makes it . . . and makes it better. The types, ranges and case styles are endless. What is "special" to other instrument makers is often standard to Marsh. To know the scope of Marsh instruments—

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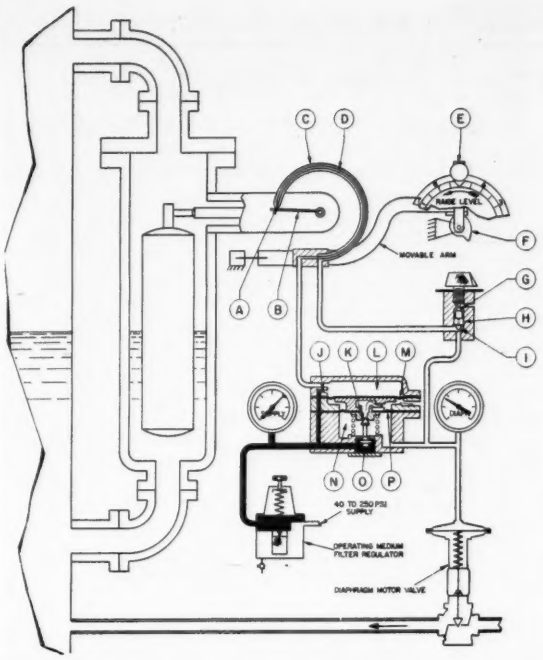
Dept. 42, Skokie, Ill. *Export Dept.,* 3501 Howard St., Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alta.

For more information circle **178** on inquiry card.



pneumatic signal that will be directly proportional to level position . . . The ratio of the two diaphragm areas ("M" and "P") in the relay is 3 to 1, or such that 5 pounds change on large diaphragm "M" results in a 15-pound change in pressure to the diaphragm control valve . . . (*From new 32-page Bulletin F-4, Fisher Governor Co., Marshalltown, Iowa*)

For this literature circle **509** on inquiry card.

SYSTEMS ENGINEERING

Openings now exist at BATTELLE in the following areas:

MATHEMATICAL and STATISTICAL ANALYSIS
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Employment on Battelle's Systems Engineering staff assures an opportunity to engage in an activity of a professional nature. Advanced degrees are obtainable, at no cost to the staff member, through BATTELLE'S TECHNICAL EDUCATIONAL PROGRAM. OUTSTANDING BENEFIT PROGRAM including FOUR WEEKS VACATION after only five years employment offered by this research organization employing 3,000, two-thirds of whom are engaged directly in the research effort.

For descriptive material and technical application form, write to

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Technical Personnel Manager
BATTELLE INSTITUTE
505 King Avenue **Columbus 1, Ohio**

FOR TESTING FABRICS THAT MUST HOLD GAS

The Cambridge Fabric Permeameter is an accurate, rugged and convenient instrument for production testing of the permeability of fabrics which are to be inflated with Hydrogen, Helium, Carbon Dioxide, etc.

The rate of permeation through the fabric is quickly determined by equipment utilizing the thermal conductivity method and is indicated in terms of liters per square meter per 24 hours of the retained gas.

Manufacturers of fabrics for lighter-than-air Craft, Life Rafts, Life Jackets, Gas Masks, etc., will find this an indispensable instrument. Send for particulars.

CAMBRIDGE INSTRUMENT CO., INC.
3526 Grand Terminal, New York, N.Y.

CAMBRIDGE FABRIC PERMEAMETER

For more information circle **179** on inquiry card.

DC-AC CHOPPERS

For 60 Cycle Use

Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

Long life.

Low noise level.

Extreme reliability.

Write for Catalog 370.

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ARNOLD

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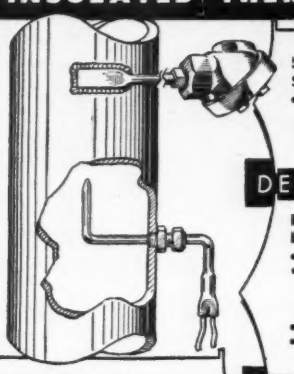
For more information circle **180** on inquiry card.

***SWAGED MGO** FOR OPERATING TEMPERATURES −300 to 2000°F
INSULATED THERMOCOUPLES



SURFACE with STANDARD T/C Head
- Extremely accurate since junction can be welded to surface.

DESIGNING

IMMERSION with LEAD WIRE ADAPTOR
- Fast time response
- Install in any pipeline without a thermo-well by simply drilling and tapping.
- Pressure and vacuum tight.
- Variable immersion depth —easily replaced.

LEAD WIRE with QUICK DISCONNECT
- Available in long lengths or spliced together to meet your length requirements.

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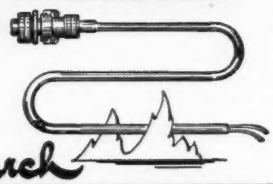

*SWAGED MgO wire is available from our stock—Diam. .025 to 5/16". SEND FOR BULLETIN 4.

Aero Research
INSTRUMENT COMPANY, INC.
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Sales Representatives throughout the United States and Canada

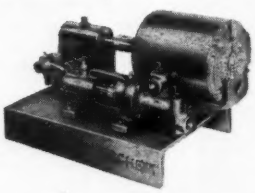
For more information circle **181** on inquiry card.

INTRODUCING
the
"ORCHEM MITY-MITE"
PROPORTIONING PUMP

Recommended particularly for low volume, boiler chemical feed applications. Excellent for many chemical process metering requirements.

Adjustable from 0 to 100% of capacity. No springs to retard self-cleaning of checks. Accessibility without breaking pipe connections.

SIMPLEX with ⅓ H.P. motor
$155.00 F.O.B. Phila.



DUPLEX with ⅓ H.P. motor
$198.00 F.O.B. Phila.

Plunger Diameter	RPM	Capacity		Maximum Pressure
		Simplex	Duplex	
7/16	70	3 GPH	6 GPH	610 PSI
5/8	70	6 GPH	12 GPH	325 PSI

WRITE FOR BULLETIN 8-56-1

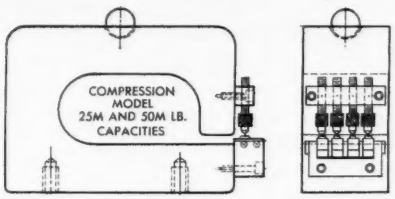
ORCHEM PUMPS, INC.
Controlled Volume Chemical Pumps
4434-36 SALMON STREET PHILADELPHIA 37, PENNA.

For more information circle **182** on inquiry card.

BRIEFS—CONTINUED

Force Control Switch

Operation of the DILLON Force Control Switch centers around a "U" shaped beam which, when compressed at ball contact, deflects inwardly. As many as four control



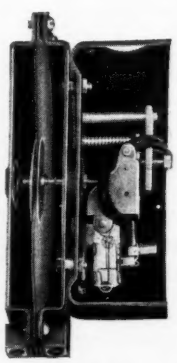
switches may be mounted on one side of the open end . . . Describing a typical setup, it might be necessary to trigger a series of devices at 200, 450, 650 and 900 pounds . . . (*From new 4-page Bulletin 28E, W. C. Dillon Company, Inc., 14620 Keswick St., Van Nuys, Calif.*)

For this literature circle **510** on inquiry card.

Electrocaloric Flowmeter

This new, accurate device is especially suitable for measuring, recording and controlling acids and alkalis (HCL, HF, NAOH, KOH, etc.), explosive fluids (gasoline), inflammable gases (manufactured and natural gases, etc.) and slurries . . . The Flow Cell measuring elements are not in contact with the fluid and, therefore, are not exposed to chemical and mechanical attack or subject to clogging.

Flowmeter accurately measures and totalizes the mass rate of flow by measuring the rate of heat transfer



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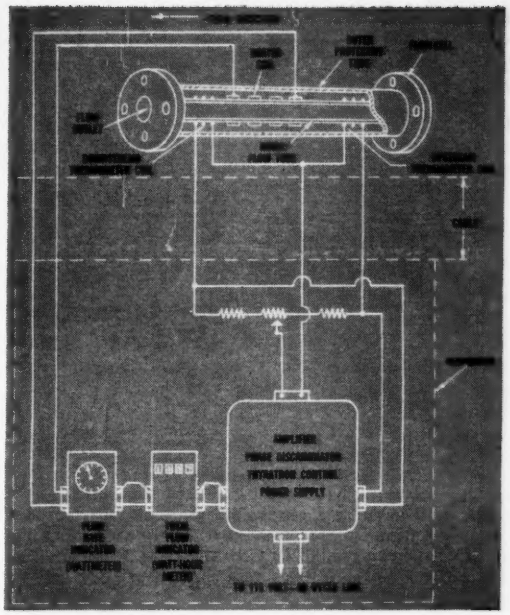

through the boundary layer of fluid . . . Heat is produced electrically in the heater coil, wound around outside of flow tube. The differential is a function of both the fluid mass flow rate and the power dissipated in the heater coil . . . (*From new 4-page bulletin "Laub Electro-Caloric Flowmeter," Industrial Development Laboratories, Inc., 17 Pollock Ave., Jersey City 5, N. J.*)

For this literature circle **511** on inquiry card.

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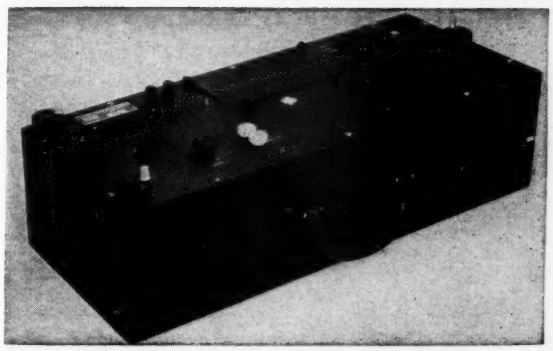

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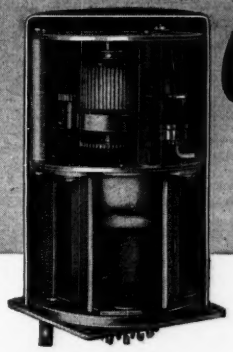

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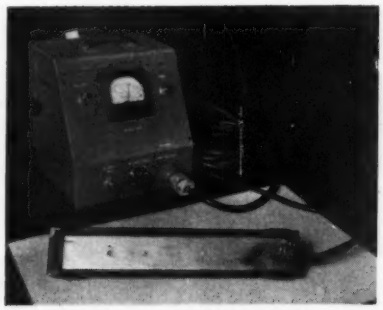

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BRIEFS—CONTINUED

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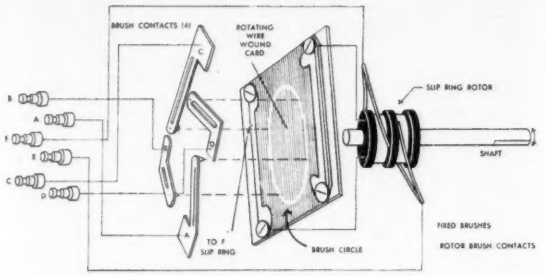

potential between the contact and any fixed point of the winding will vary in a sinusoidal manner with respect to angular rotation . . . (*From new 20-page Catalog "Precision Potentiometers," The Gamewell Co., Newton Upper Falls, Mass.*)

For this literature circle **512** on inquiry card.

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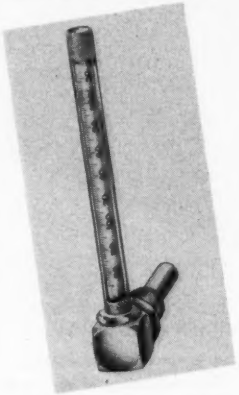

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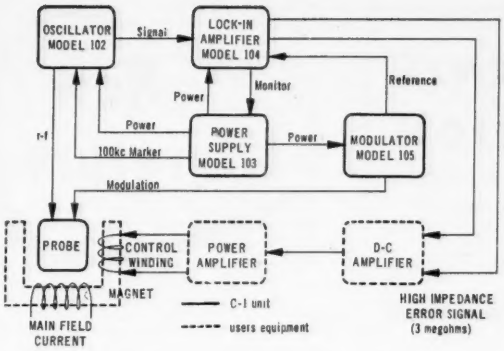
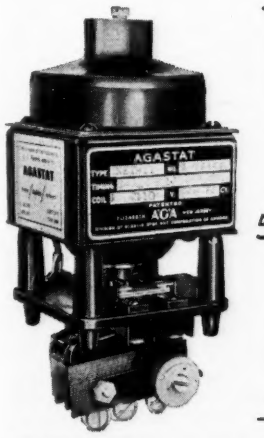


containing sample material, is positioned within the magnetic field to be controlled. The sample material absorbs r-f energy at a particular resonant frequency which is determined by the strength of the magnetic field and the known gyromagnetic ratio of the sample material. The r-f energy is applied by means of a coil in the probe which surrounds the sample. The coil is connected by a cable to a tunable oscillator arranged to provide an indication of circuit losses in the coil such as are introduced by the r-f energy absorption in the sample at resonant frequency . . . The C-1 Control System will maintain the difference between the actual field and the reference field, established by the oscillator frequency, to one part in 10^5 or a tenth of a line width, whichever is greater . . . . Four color-coded probes are included to cover the gauss range from 300 to 18,750 gauss . . . (*From new 4-page bulletin "Magnetic Field Control System, Model C-1, Nuclear Magnetics Corp., 154 Boylston St., Boston, Mass.*)

For this literature circle **513** on inquiry card.



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INSTRUMENTS and AUTOMATION

New Literature

AUTOMATION

Operations Control. New 20-page bulletin presents applications of maker's equipment for new-product development, basic research, process monitoring and control, dynamic testing, vacuum technology, automatic data processing, etc.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **514** on inquiry card.

Systems Engineering. New 16-page Bulletin CEC-1304A describes operation and makeup of CEC's System Division. Presents several representative systems application problems along with their solutions—Consolidated Electrodynamics Corp., Systems Div., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **515** on inquiry card.

Meters and Controls. New 8-page Bulletin G15-1 gives pictorial and descriptive review of maker's measuring, transmitting, receiving and recording instruments for power and process applications.—Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.
Circle **516** on inquiry card.

Electrical Transmitter. New 4-page Bulletin MYP-508 presents operation and maintenance of maker's ring balance electrical transmitter.—Hagan Corp., Pittsburgh 30, Penna.
Circle **517** on inquiry card.

Atomic Energy Plant Controls. New 8-page bulletin describes electro-hydraulic controls, heat transfer apparatus, remote television, servo systems and ceramics for application in atomic energy plants made by four subsidiary companies of General Precision Equipment Corp.—Advertising Dept., Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.
Circle **518** on inquiry card.

Electronic Controllers. New 8-page Bulletin MYP-600 describes operation and maintenance of Model CAO and Model CPO electronic controllers for high performance and high-speed processes.—Hagan Corp. Pittsburgh 30, Pa.
Circle **519** on inquiry card.

Instruments and Gages. New 72-page catalog presents charts, diagrams and illustrations of maker's gages for measuring combustion, draft, pressure, flow, vacuum, CO_2, smoke, velocity, etc. and includes price list.—F. W. Dwyer Mfg. Co., P. O. Box 373, Michigan City, Ind.
Circle **520** on inquiry card.

Packaged Machine Control. New 12-page Bulletin GEA-6334 presents applications of "Pan-A-Trol" control panels and benefits in engineering assistance, design, installation, maintenance, etc. offered by company.—General Electric Co., Schenectady 5, N. Y.
Circle **521** on inquiry card.

Photoelectric Systems. New 24-page illustrated Brochure PA-561 presents specifications on maker's "packaged" photoelectric systems for industrial control applications.—Photoswitch Div., Electronics Corp. of America, One Memorial Drive, Cambridge 42, Mass.
Circle **522** on inquiry card.

Automatic Instrumentation Components. Six new 2-page bulletins in folder describe maker's automatic instrumentation components and systems.—Fairchild Electrotechnics Div., Fairchild Engine & Airplane Corp., 118 E. 16th St., Costa Mesa, Calif.
Circle **523** on inquiry card.

Industrial Instrumentation. New 4-page Bulletin F-403 pictures and describes maker's recording, indicating and controlling instruments for industrial processing.—Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Phila. 33, Pa.
Circle **524** on inquiry card.

Control Systems. New 16-page Bulletin 136 describes maker's pulse control systems for testing cores by digital techniques.—Burroughs Corp., Electronic Insts. Div., 1209 Vine St., Phila. 7, Pa.
Circle **525** on inquiry card.

Control Units. New 4-page illustrated brochure describes maker's "Cy-Co-Trol" tool control units.—Royal Design and Mfg., Inc., 4133 E. Ten Mile Rd., Center Line, Mich.
Circle **526** on inquiry card.

Remote Metering System. New 2-page bulletin describes maker's remote metering system for electronically monitoring any process variable.—Sparton Control Systems Div., Sparks-Withington Co., Jackson, Mich.
Circle **527** on inquiry card.

Process Control. New 12-page bulletin describes services available to process industries for specifying component sizes for an optimum system, calculating "payout" for new features or additional system complexity, etc.—Feedback Controls, Inc., Dept. IA, Waltham, Mass.
Circle **528** on inquiry card.

Control Unit. New 4-page Bulletin ST-1 describes maker's electronic—hydraulic control unit.—The Swiss Colony, Engineering Div., Monroe, Wis.
Circle **529** on inquiry card.

Excitation System. New 8-page Bulletin 5.08 describes maker's McHenry excitation system.—Electric Regulator Corp., Pearl St., Norwalk, Conn.
Circle **530** on inquiry card.

Systems Engineering. New 4-page Bulletin SE-1-000 presents systems engineering and analog computing services. 2-page Bulletin A-1-000 describes power amplifier; 2-page Bulletin SM-1-000 describes servos; 2-page specification sheets describes signal converter.—Dynalysis Development Laboratories, Inc., 11941 Wilshire Blvd., Los Angeles 25, Calif.
Circle **531** on inquiry card.

Magnetic Control. New 8-page Technical Data 52-760 describes maker's "Cypak" plug-in, magnetic control, logic functions for industrial control without moving parts or operating contacts.—Westinghouse Electric Corp., 401 Liberty Ave., Box 2278 Pittsburgh 30, Pa.
Circle **532** on inquiry card.

VALVES

Diaphragm Control Valve. New 4-page Bulletin 0-125P describes and illustrates maker's "Series 125P" high-pressure diaphragm control valve.—Fisher Governor Co., Marshalltown, Iowa.
Circle **533** on inquiry card.

Gas Regulators. New 4-page Bulletin P-67 presents maker's "Series 883 and 885" high-pressure gas regulator valves.—Fisher Governor Co., Marshalltown, Iowa.
Circle **534** on inquiry card.

Butterfly Valves. New Specification Sheet RM-1000 describes maker's line of V-Port butterfly valves for precise control of air or gas.—Hagan Corp., 323 Fourth Ave., Pittsburgh 22, Pa.
Circle **535** on inquiry card.

Sampling Valve. New 2-page Data Sheet 294 presents information on maker's drain or sampling valve. New 2-page Data Sheet 293 presents details of maker's gage glass cleaning rod.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.
Circle **536** on inquiry card.

Valves. New 140-page Catalog 55 describes and illustrates (in simulated blueprint form) in 7 sections company's reverse current, spring relief, atmospheric relief, non-lubricated plug, and pressure regulating valves and accessories, for power plant, industrial, marine and special devices.—Atwood & Morrill Co., Salem, Mass.
Circle **537** on inquiry card.

Hydraulic Valves. New 92-page Catalog describes and illustrates maker's oil hydraulic valves for controlling fluid power.—The Commercial Shearing and Stamping Co., 1775 Login Ave., Youngstown 1, Ohio.
Circle **538** on inquiry card.

Globe Valves. New 4-page illustrated Bulletin 602-2 describes maker's "LQ600" bronze globe valves.—Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.
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Control Valves. New 8-page Catalog 56C pictures and describes maker's

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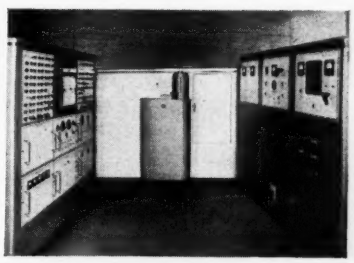

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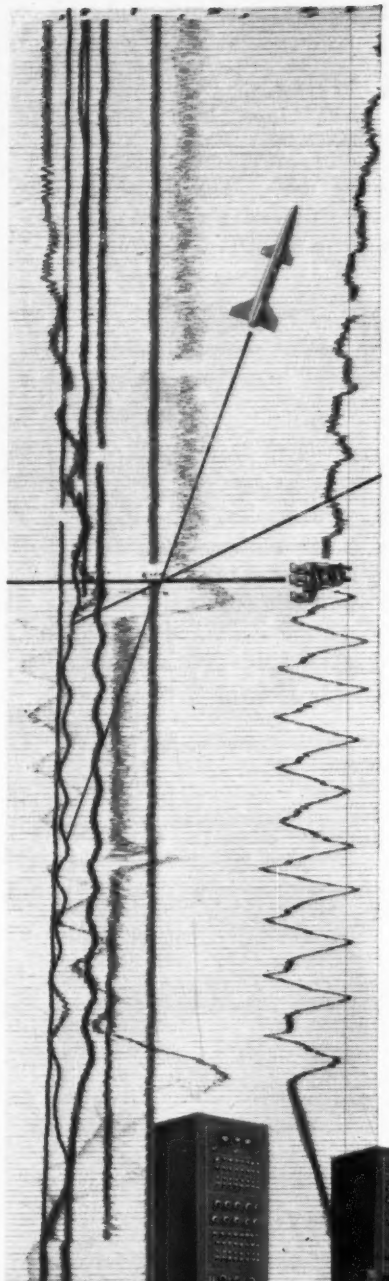

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NEW LITERATURE

automatic pressure, temperature and level control valves for process control.—Atlas Valve Co., 280 South St., Newark 5, N. J.
Circle **540** on inquiry card.

MOTORS, SERVOS

Motors. New 11-page Bulletins GEC-1026A and GEC-1027A provide application data, ratings and prices for fractional hp motors, integral-hp polyphase and single-phase induction motors, gear-motors, etc.—General Electric Co., Schenectady 5, N. Y.
Circle **541** on inquiry card.

Servo Equipment. New 16-page Short-Form Catalog SF-9901-56 describes maker's equipment for industrial control systems, infrared measurement and control, communication and navigation.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.
Circle **542** on inquiry card.

Electric Motors. New Bulletin AL-4 describes maker's FHP electric motors.—Redmond Co., Inc., Owosso, Mich.
Circle **543** on inquiry card.

Motor Capacitors. New 4-page Bulletin 179 presents maker's "Type KGN" a-c motor capacitors in rectangular fabricated cases.—Cornell-Dubilier Electric Corp., South Plainfield, N. J.
Circle **544** on inquiry card.

Micromotor. New 4-page Brochure AL-4 describes and illustrates maker's "Type AL-4 Tri-Flux" patented shaded pole micromotor.—Redmond Co., Inc., Owosso, Mich.
Circle **545** on inquiry card.

Fluid Drives. New 8-page illustrated Bulletin 9819 describes maker's 1 through 25 hp "Type VS-Class 2" Gyrol Adjustable speed fluid drives.—American Blower Corp., Hydraulic Coupling Div., Detroit 32, Mich.
Circle **546** on inquiry card.

TEMPERATURE

Thermistors. New 56-page Manual #TH-13A describes and illustrates maker's thermally sensitive resistors with characteristic curves.—General Electric, Metallurgical Products Dept., Detroit 32, Mich.
Circle **547** on inquiry card.

Thermocouple Protecting Tubes. New 2-page Bulletin 1000-56 describes and illustrates maker's "Serv-Rite" line of ceramic protecting tubes.—Claud S. Gordon Co., Chicago, Ill.
Circle **548** on inquiry card.

Thermocouple Insulators. New 4-page Bulletin 300-56 illustrates and describes maker's complete line of "Serv-Rite" thermocouple insulators.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.
Circle **549** on inquiry card.

Temperature Controls. New 4-page "Model TE" Bulletin RT-771 describes maker's Model TE "Thermal-Eye" temperature control device.—Robertshaw-Fulton Controls Co., 110 East Otterman St., Greensburg, Pa.

Circle **550** on inquiry card.

Temperature Control. New 4-page Bulletin RT-754 describes maker's Model BJ-TE "Thermal-Eye" temperature regulating device for gas topburners.—Robertshaw-Fulton Controls Co., 110 East Otterman St., Greensburg, Pa.

Circle **551** on inquiry card.

Temperature Cabinets. New 4-page bulletin describes maker's hot and/or cold temperature cabinets for industrial applications from +300° F to —200° F. New 2-page Bulletin 62 describes sub-zero rivet coolers.—Webber Engineering Corp., P. O. Box 217, Indianapolis, Ind.

Circle **552** on inquiry card.

Self-ignition Apparatus. New 18-page Bulletin (Vol. 53, No. 1) features article on "Self-Ignition Temperatures of Combustible Liquids".—Research Appliance Co., Box 307, Allison Park, Pa.

Circle **553** on inquiry card.

Hydrometers, Thermometers. New 40-page Catalog 211 lists hydrometers and thermometers, including special and unusual ranges.—Wm. Hiergesell & Sons, 295 Pearl St., New York 38, N. Y.

Circle **554** on inquiry card.

PRESSURE, WEIGHT

Pressure Cells. New 2-page Bulletin 271 describes maker's "Celab" pressure cells.—Clark Electronic Labs., Box 165, Palm Springs, Calif.

Circle **555** on inquiry card.

Pressure Transducers. Three new bulletins present models of maker's pressure transducer: 8-page bulletin presents "Model S-3"; and two 4-page bulletins cover "Models S-6A and S-6B".—Ultradyne Engineering Labs., Inc., P. O. Box 8007, Albuquerque, New Mexico.

Circle **556** on inquiry card.

Belt Conveyor Scale. New 6-page data sheets presents information on maker's unitized weighing belt conveyor scale.—Weighing Components, Inc., 64 Fulmore Rd., Hatboro, Pa.

Circle **557** on inquiry card.

Bagging Scale. New 6-page Bulletin 0156 describes and illustrates maker's "GA-38" automatic bagging scale.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

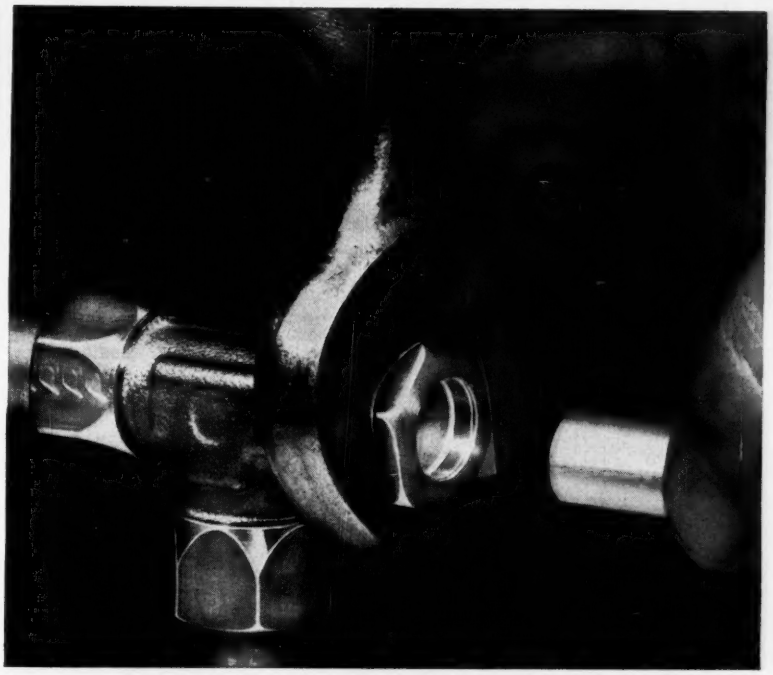
Circle **558** on inquiry card.

Scales. New 6-page folder describes maker's scales for batching, blending, sorting, packaging, etc.—The Exact Weight Scale Co., Columbus 8, Ohio.

Circle **559** on inquiry card.

Balances. Two 2-page data sheets presents maker's analytical balance accurate to 1/100,000 of capacity, and self-balancing 5,000 gm capacity scale.—Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Circle **560** on inquiry card.



Simply push, then tighten! Anyone can quickly install all-new, *lightweight Intru-lok* tube fittings . . . the proven Parker 3-piece flareless design. Just insert the tube, then tighten the nut with a regular wrench . . . for a leakproof, vibration-proof joint. Made of brass for copper or nylon tubing. Send for complete details in Catalog 4324.

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For soft plastic tubing you use knurled nut and expander insert with new *Intru-lok* body. Joints can be disconnected and reassembled. Complete details in Catalog 4324. Send for it.

Weld-lok fittings, for extreme temperatures, corrosion conditions . . . machined from high-quality steel or stainless bar stock and forgings . . . for tubing ¼" through 2" O.D.

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Parker

Hydraulic and fluid system components

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Model 2 Phase Comparator

...can be used as a modulator, demodulator or switch

This compact, rugged comparator is hermetically sealed in an inert gas and packaged for mounting in a standard octal socket. Two full-wave bridge rectifiers are used to obtain a high degree of stability and balance.

As phase sensitive comparators, these units can be used to measure the amplitude or phase of an input signal with respect to a reference signal. As demodulators, DC output can be obtained either single-ended or push-pull with respect to ground. Suitable for all military applications.

SPECIFICATIONS

Frequency Response: 0 to 5000 CPS; ***Max. Reference Voltage:*** 120V. RMS; ***Max. Output Voltage:*** ± 50V. DC; ***Dynamic Range:*** 46 db; ***Load:*** Max. 200K ohms, — Min. 20K ohms; ***Input Impedance:*** Approx. 200K ohms with 200K ohms load and 1:1 transformer. ***Size:*** 1″ dia. x 3″; ***Weight:*** 2 ozs.

Write for data sheets to Dept. IA-10

SANDERS ASSOCIATES INCORPORATED
NASHUA, NEW HAMPSHIRE

For more information circle **198** on inquiry card.

NEW LITERATURE

FLOW, PUMPS

Flowmeters. New 12-page Bulletin 130 describes and illustrates maker's armored "Rotameters". Price Lists 190, 130 and 110 cover special service, armored, and full-view rotameters.—Brooks Rotameter Co., Lansdale, Pa.
Circle **561** on inquiry card.

Filter Pump Units. New 4-page Bulletin 102 presents new centrifugal-type, all-plastic filter pumps for corrosive solutions, said to remove particles down to 1 micron.—Sethco Mfg. Co., 70 Willoughby St., Brooklyn 1, N. Y.
Circle **562** on inquiry card.

Vacuum Pumps. New 2-page issue of "Engineering News-Letter" (Vol. 1, No. 4) describe maker's vacuum pumps for handling corrosive vapors, also a bypass rotameter and finned-coil heat exchanger.—Schutte and Koerting Co., 2255 State Road, Cornwells Heights, Bucks County, Pa.
Circle **563** on inquiry card.

HUMIDITY

Humidity Instruments. New 22-page Bulletin H1009 presents maker's instruments for indicating, recording and automatic control of relative humidity and temperature.—The Bristol Co., Waterbury 20, Conn.
Circle **564** on inquiry card.

LEVEL

Liquid-Level Gage. New 8-page Bulletin 291 describes maker's "Truscale" gage that flashes red warning when boiler water level gets too high or too low.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.
Circle **565** on inquiry card.

Liquid Level Control. New 2-page Bulletin ALC-2.3 describes maker's "MEK-3001A" fail safe probe type liquid level control.—Machinery Electrification, Inc., Northboro, Mass.
Circle **566** on inquiry card.

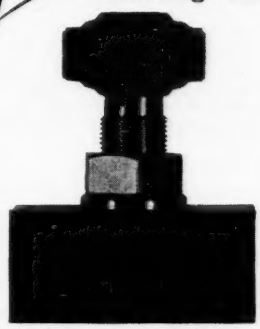
SPEED, TIME

Tachometers. New 4-page Bulletin 105 describes and illustrates maker's stationary tachometers, speed indicators for general use, takeoff heads for medium speeds, and speed controls and recorders.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colorado.
Circle **567** on inquiry card.

Speed Control. New 4-page Bulletin C-100 describes maker's variable speed control for electrical or pneumatic systems via variable speed drive.—Graham Transmissions, Inc., Menomonee Falls, Wis.
Circle **568** on inquiry card.

Cycle Timer. New 4-page Bulletin 323 pictures and describes maker's

ROBBINS **Leakproof Metering Valves**



- Hi Vacuum to 6000 PSI.
- "O" Rings and Teflon or Nylon Seats are standard.
- Over-torquing cannot damage seat or needle as buffer plate and metering pin act as a forming die.
- Impossible to score needle or seat.
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Write for further details.
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done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 50 years.

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multipulse repeat cycle timer.—Eagle Signal Corp., Moline, Ill.
Circle **569** on inquiry card.

AIR, SMOKE, STEAM

Compressor. New 4-page illustrated bulletin presents data on maker's line of oil-free air compressors.—Squire-Cogswell Co., Dept. 79, 4151 North Kedzie Ave., Chicago 18, Ill.
Circle **570** on inquiry card.

Smoke and Combustion Controller. New 2-page Data Sheet 10.14-2a describes maker's smoke density measuring system using Brown ElectroniK recorders.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Phila. 44, Pa.
Circle **571** on inquiry card.

Combustion Control. New 20-page booklet features article on "Control Fundamentals—Their Application to Combustion".—Cleveland Fuel Equipment Co., 1111 Brookpark Rd., Cleveland 9, Ohio.
Circle **572** on inquiry card.

Boiler Controls. New 8-page Bulletin C-63 describes and prices maker's boiler controls, including water level controls, relief valves, and safety devices. New 16-page Bulletin M-71 is service guide for boilers.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.
Circle **573** on inquiry card.

MOTION, VIBRATION

Displacement Transducers. New 2-page bulletin illustrates and describes maker's displacement transducers.—Colvin Laboratories, Inc., East Orange, N. J.
Circle **574** on inquiry card.

Shock, Vibration Recorder. New 4-page Bulletin 7.5M describes and illustrates maker's impact, acceleration and gravity recorders.—The Impact-O-Graph Corp., 1900 Euclid Ave., Cleveland 15, Ohio.
Circle **575** on inquiry card.

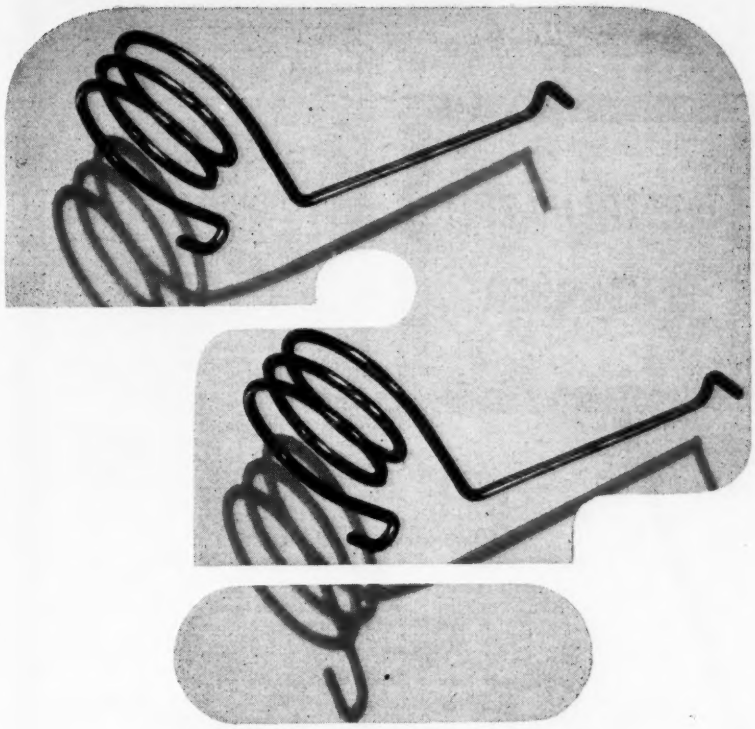
SOUND, NOISE

Acoustical Research. New 20-page issue of Bruel & Kjaer "Technical Review" (July 1956, No. 3) features article on "Determination of Acoustical Quality of Rooms from Reverberation Curves."—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **576** on inquiry card.

Noise Measurement. New 28-page issue of Bruel & Kjaer "Technical Review" (No. 4, 1955) describes measurements of sound, vibration and strain. Contains conversion table from decibels to sones.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **577** on inquiry card.

Loudspeakers. New 24-page Bulletin 1070 presents maker's professional loudspeakers including: drivers, rectangular horns, transformers, hi-fi, etc.—Jensen Manufacturing Co., 6601 S. Laramie Ave., Chicago 38, Ill.
Circle **578** on inquiry card.

Damping Meter. New 28-page leaflet describes maker's "Type DM 4 Dampometer," for recording the dampening of harmonic oscillations.



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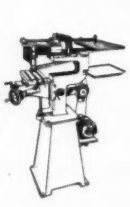

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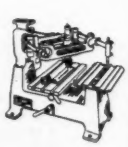

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NEW LITERATURE

Includes two 2-page bulletins describing maker's universal 2-channel dc amplifier and Dampometer.—Oltronix, 235 Underwood Drive, Atlanta 5, Ga.
*Circle **579** on inquiry card.

RECORDERS

Photo Panels. New 4-page brochure describes use of xerography in preparing and altering lists for photo panels, etc.—The Haloid Co., 20 Haloid St., Rochester 3, N. Y.
Circle **580** on inquiry card.

High-speed Cameras. New 12-page Bulletin F1-2 describes and illustrates maker's high-speed motion picture cameras and accessories.—Eastman Kodak Co., Rochester 4, N. Y.
Circle **581** on inquiry card.

TESTING, GAGING

Friction. New 24-page issue of Bruel & Kjaer "Technical Review" (April 1956, No. 2) features article on "Use of Resistance Strain Gages to Determine Friction Coefficients."—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **582** on inquiry card.

Spirit Levels. New 4-page Bulletin 7200 describes maker's spirit level vials.—W. & L. E. Gurley, Troy, N. Y.
Circle **583** on inquiry card.

Electronic Micrometers. New 4-page descriptive Bulletin 4003 illustrates maker's hand-operated electronic micrometers for direct, pressureless measurements.—J. W. Dice Co., Englewood, N. J.
Circle **584** on inquiry card.

Testing Instruments. New 8-page Catalog CS-56 presents illustrations and descriptions of maker's instruments for testing textiles, plastics, paper, insulation, extensometers, dial indicators, light metals, etc.—Custom Scientific Instruments, Inc., 541 Devon St., Kearny, N. J.
Circle **585** on inquiry card.

Abrasion Testing Set. New 6-page Bulletin 5604 pictures and describes maker's "Model 174" automatic abrasion testing set.—Taber Instrument Corp., 111 Goundry St., Section 59, North Tonawanda, N. Y.
Circle **586** on inquiry card.

Testing Machines. New 6-page Brochure 562 describes construction, operation and function of maker's vibration fatigue testing equipment.—All American Tool & Mfg. Co., 8027 Lawndale Ave., Skokie, Ill.
Circle **587** on inquiry card.

Air Gaging. New 12-page Catalog IPC-6-56 presents principles of air gaging with maker's "Precisionaire" column air-gaging instruments.—The Sheffield Corp., Div. 610, Dayton 1, Ohio.
Circle **588** on inquiry card.

Projection Gaging. New 12-page Bulletin F2-126 describes and illustrates maker's contour projectors and

accessories.—Eastman Kodak Co., Rochester 4, N. Y.

Circle **589** on inquiry card.

COMPUTING, DATA HANDLING, COUNTING

Analog-to-Digital Converters. New 4-page Bulletin 372 describes and illustrates maker's analog-to-digital converters. Includes applications.—Norden-Ketay Corp., Instrument & Systems Div., Wiley St., Milford, Conn.

Circle **590** on inquiry card.

Data System. New 16-page Brochure 494 describes maker's "Model 111" data system used in monitoring, recording and processing functions.—Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle **591** on inquiry card.

File Computer. New 4-page Bulletin PX71990 presents maker's "UNIVAC" file computer used for airlines reservation system.—Remington Rand Univac, Div. of Sperry Rand Corp., 1902 W. Minnehaha Ave., St. Paul W4, Minn.

Circle **592** on inquiry card.

Analog-to-Digital Encoder. New 4-page Bulletin 0756 presents maker's sub-miniature optical shaft position indicator.—The Baldwin Piano Co., 1801 Gilbert Ave., Cincinnati 2, Ohio.

Circle **593** on inquiry card.

Magnetic-Tape Handler. New 2-page bulletin describes and illustrates maker's "Model 101" digital magnetic-tape handler.—Key Electric Corp., 287 Post Ave., Westbury, N. Y.

Circle **594** on inquiry card.

Counters. New 6-page Catalog 400 presents maker's "Y" digital read-out counters.—Durant Manufacturing Co., 1929 N. Buffum St., Milwaukee 1, Wis.

Circle **595** on inquiry card.

OPTICAL

Electric Eyes. New 14-page Bulletin 562 describes and illustrates applications of maker's miniaturized electric eyes.—Ess Instrument Co., 96 S. Washington Ave., Bergenfield, N. J.

Circle **596** on inquiry card.

Lighting System. New 20-page booklet describes maker's "Sylvan-Aire" system of wall-to-wall lighting.—Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

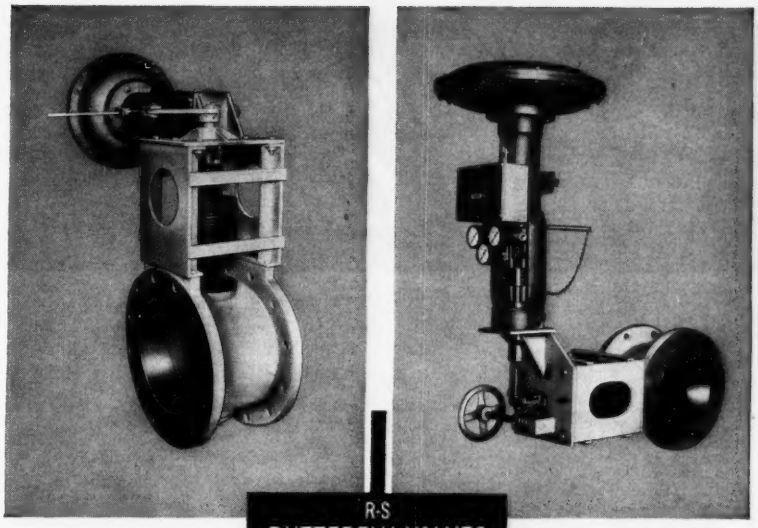
Circle **597** on inquiry card.

Microscopy Accessories. New 16-page booklet describes and illustrates maker's carbon specimen film and replica kit, rotating specimen support head, tungsten wire baskets, and other accessories for microscopy.—Ernest F. Fullam, Inc., P. O. Box 444, Schenectady 1, N. Y.

Circle **598** on inquiry card.

MONITORS

Chlorine Detector. New 4-page Bulletin 50.118 pictures and describes maker's "Series A-689" chlorine detector for warning of chlorine concentrations in air in excess of a pre-



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Special 12-inch R-S Butterfly Valve, with finned lubricated stuffing box, for service with hot gases at 1,000° F.

6-inch, raised-face R-S Butterfly Valve for elevated temperatures.

SPECIAL R-S VALVES SOLVE TEMPERATURE, CORROSION, ABRASION PROBLEMS

To meet rugged processing conditions, R-S Butterfly Valves can be built to your requirements. For valve bodies and parts, any metal or other material that can be cast or welded — even plastics — may be specified.

There are a number of materials available to meet extreme working conditions involving corrosion, abrasion, erosion, high heat and pressure. In addition, the R-S Rubber-lined Valve may be specified to resist certain types of corrosion. Every R-S Valve gives you quick and positive closure with any type of controls, uniform control in normal regulating ranges and minimum pressure drop.

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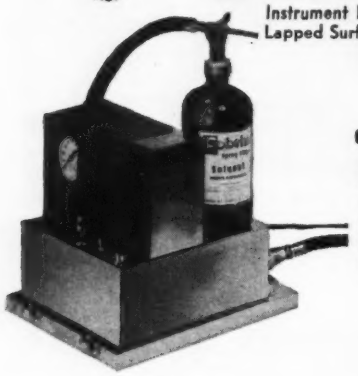

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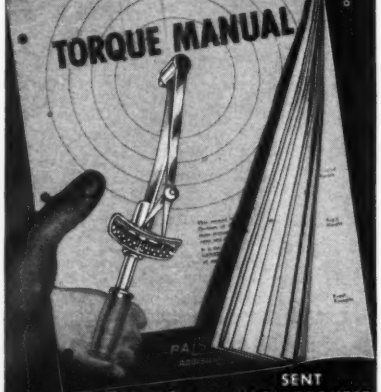

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NEW LITERATURE

selected value.—Wallace & Tiernan, Inc., 25 Main St., Belleville 9, N. J.
Circle **599** on inquiry card.

Gas Alarm. New 2-page descriptive Bulletin E-556-5M illustrates maker's J-W "Model E" combustible gas alarm. Includes prices.—Johnson-Williams, Ltd., Palo Alto, Calif.
Circle **600** on inquiry card.

Ultraviolet Lamp. New 2-page Bulletin B-100 pictures and describes maker's "Model B-100 Blak-Ray" longwave ultra-violet source for chromatography, laboratory research and medical observation.—Ultra-Violet Products, Inc., 5114 Walnut Grove Ave., San Gabriel, Calif.
Circle **601** on inquiry card.

ANALYTICAL, LABORATORY

Analytical Instruments. New 4-page Bulletin 491 describes and illustrates maker's electrolytic hygrometer, infrared analyzer, leak detector, flow colorimeter, etc.—Beckman Instruments, Inc., Fullerton, Calif.
Circle **602** on inquiry card.

Infrared Spectroscopy. New 8-page Bulletin 18 features articles on infrared spectroscopy and data processing.—Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.
Circle **603** on inquiry card.

Spectrophotometer. New 4-page illustrated Bulletin CH 370/3 describes British-made (Hilger & Watts, London) "Unispek" spectrophotometer.—The Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.
Circle **604** on inquiry card.

Carbon and Sulfur Determinator. New 16-page Bulletin 10-M-355 presents carbon and sulfur determination equipment for metals, petroleum catalysts, rubber, organic and inorganic materials, etc.—Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.
Circle **605** on inquiry card.

Gas Chromatography. New 2-page Bulletin H-TC7-56 presents maker's thermal conductivity cell for gas chromatography.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.
Circle **606** on inquiry card.

Laboratory Ware. New 4-page illustrated Bulletin M 1017 presents data on maker's glass and teflon needle valves with Pyrex brand glassware.—The Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.
Circle **607** on inquiry card.

Laboratory Items. New 4-page bulletin presents maker's polyethylene laboratory ware with prices.—Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago 22, Ill.
Circle **608** on inquiry card.

Laboratory Balances. New 32-page Catalog AW-13 describes and illustrates maker's analytical automatic balances, micro balances, assay balances, weight sets, etc.—William Ains-

worth & Sons, Inc., 2151 Lawrence St., Denver, Colorado.
Circle **609** on inquiry card.

Molecular Still. New 4-page bulletin describes and illustrates maker's 2 in. "Rota-Film" molecular still.—Arthur F. Smith Co., Rochester 3, N. Y.
Circle **610** on inquiry card.

AIRCRAFT

Fuel Pump. New 2-page Data Sheet 3-81 describes and illustrates maker's "Model RG-15800" electric motor driven aircraft fuel pump.—Lear, Inc., Lear-Romec Div., Elyria, Ohio.
Circle **611** on inquiry card.

Flight Attitude Indicator. New 12-page illustrated brochure describes maker's "Model 1035" flight attitude indicator.—Summers Gyroscope Co., 2328 Broadway, Santa Monica, Calif.
Circle **612** on inquiry card.

RADIO, COMMUNICATIONS, ITV

Audio Amplifiers. New 32-page brochure "Application Notes" on transistor audio amplifiers.—General Electric Co., Semiconductor Products, Dept., Syracuse, N. Y.
Circle **613** on inquiry card.

Wireless Intercom. New 4-page bulletin describes and prices maker's "Port-A-Phone" portable wireless intercom.—General Industrial Co., 5736B Elston Ave., Chicago 30, Ill.
Circle **614** on inquiry card.

VHF Receiver. Two new 2-page specification sheets describe maker's "Model R 5200" VHF receiver used for monitoring, meteor research, flight-testing, etc., and maker's "Model 503" 5000 volt dc power supply.—Servo Corp. of America, New Hyde Park, N. Y.
Circle **615** on inquiry card.

ITV Camera. New 2-page Specification Sheet PD-152 describes maker's ruggedized television camera designed for operation in high vibration and noise environments.—General Precision Lab., 63 Bedford Rd., Pleasantville, N. Y.
Circle **616** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Signal Generator. New 8-page Catalog Sheet ED 11503 presents maker's signal generator and control system for audio frequency range.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **617** on inquiry card.

Panel Instruments. New 28-page Bulletin A-7-E presents specifications on maker's ac and dc instruments, power level meters, VU and DB meters, frequency meters and wattmeters.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Circle **618** on inquiry card.

Utility Tester. New 4-page bulletin presents maker's new utility tester for measuring voltages, currents, re-

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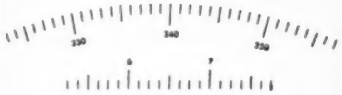

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NEW LITERATURE

sistances, leakages.—Moss Electronic Dist. Co., Inc., 3849 Tenth Ave., New York 34, N. Y.

Circle **619** on inquiry card.

Electrolysis Voltmeter. New 2-page bulletin presents maker's dual electrolysis voltmeter.—Stewart Bros., 315 W. Walton Pl., Chicago 10, Ill.

Circle **620** on inquiry card.

Shorted-Turns Indicator. New 2-page Bulletin M-1 describes maker's new shorted-turns indicator for go-no-go testing of shorts and open circuits.—B & K Mfg. Co., 3731 N. Southport Ave., Chicago 13, Ill.

Circle **621** on inquiry card.

ELECTRONIC COMPONENTS

Isolators. New 4-page illustrated Brochure W-103 describes maker's Ferrite isolators for microwave circuits, reducing frequency pulling of the magnetron, reducing moding, etc. —Kearfott Co., Inc., Western Div., 253 M. Vinedo Ave., Pasadena, Calif.

Circle **622** on inquiry card.

Printed Circuitry. New 16-page illustrated Brochure 688 presents data on maker's copper clad laminated plastics for printed circuitry.—Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Circle **623** on inquiry card.

Plug-In Components. New 4-page bulletin is quick-index guide to maker's basic components for plug-in unit construction. New 4-page folder includes "Get Started" kit and news on techniques in plug-in circuitry.—Alden Products Co., 127 N. Main St., Brockton, Mass.

Circle **624** on inquiry card.

Magnetic Cores. New 4-page Bulletin MT-103 presents maker's "S-1" ferramic magnetic cores.—General Ceramics Corp., Keasbey, N. J.

Circle **625** on inquiry card.

Plug-In Units. New 2-page Catalog 11386 presents maker's new plug-in units embedded in mica-filled epoxy with color-coded banding.—The Walkirt Co., 145 W. Hazel St., Inglewood, Calif.

Circle **626** on inquiry card.

Radio and TV Knobs. New 16-page Catalog 57 illustrates maker's line of radio-television knobs, speaker kits, etc.—Gee-Lar Mfg. Co., 400 South Wyman St., Rockford, Ill.

Circle **627** on inquiry card.

Microwave Components. New 12-page Catalog C-756 presents data on maker's X-band balanced mixers, cable connectors, single and dual crystal holders, etc.—Microwave Development Labs., Inc., 92 Broad St., Babson Park, Wellesley 57, Mass.

Circle **628** on inquiry card.

Microwave Components. New 20-page Catalog 5-6A illustrates and describes maker's microwave test equipment and waveguide components.—Lieco, Inc., 3610 Oceanside Rd., Oceanside, L. I., N. Y.

Circle **629** on inquiry card.

Nylon Bobbins and Washers. New 4-page Bulletin BW 756 presents specifications on maker's nylon bobbins and molded nylon washers.—Cosmo Plastics Co., 3239 W. 14th St., Cleveland 9, Ohio.

Circle **630** on inquiry card.

Electronic Components. New 20-page Catalog C56-B presents list of maker's miniature toggle and rotary switches, condensers, transformers, motors, dynamotors, etc.—Wells Sales, Inc., 833 W. Chicago Ave., Chicago 22, Ill.

Circle **631** on inquiry card.

Sweep Generators. New 2-page Bulletin 5M7-56 describes and illustrates maker's broad-band sweep generators and pulse markers.—Telonic Industries, 73 N. Second Ave., Beech Grove, Ind.

Circle **632** on inquiry card.

Coaxial Slotted Lines. Two new 2-page data sheets presents maker's line of standard reflections for calibrating slotted line impedance meters and standardizing reflectometers and describes (Model 230 Type N and Model 230B 7/8") coaxial slotted lines of parallel plane type.—The Narda Corp., 160 Herricks Rd., Mineola, L. I., N. Y.

Circle **633** on inquiry card.

Radio, TV Electronic Accessories. New 80-page Catalog 157 presents cements, connectors, printed circuit repair kits, and thousands more radio-TV service aids.—General Cement Mfg. Co., Rockford, Ill.

Circle **634** on inquiry card.

Electronics Catalog. New 356-page 1957 General Catalog includes 27,000 items of industrial maintenance, research and production electronic parts and equipment.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle **635** on inquiry card.

Capacitors. New 4-page Catalog 55-1B presents "Vitramon" capacitors, said to have unusually stable electrical characteristics over a wide range of temperatures and frequencies.—Vitramon, Inc., Box 544, Bridgeport 1, Conn.

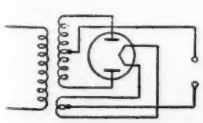
Circle **636** on inquiry card.

Power Amplifier. New 4-page Bulletin 2100 presents maker's magnetic switching amplifier "SA-2".—Magnetic Controls Co., Minneapolis, Minn.

Circle **637** on inquiry card.

Electronic Component Data Service. New 8-page bulletin presents company's electronic component data service.—Derivation and Tabulation Associates, Inc., 67 Lawrence Ave., West Orange, N. J.

Circle **638** on inquiry card.



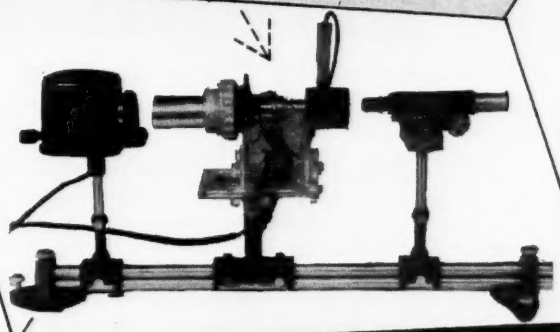
POWER SUPPLIES

Power Supply. New 2-page bulletin presents maker's "Series Z-95000" dc-ac power supply.—EECO Production Co., 506 E. First St., Santa Ana, Calif.

Circle **639** on inquiry card.

Power Rectifiers. New 4-page Bulletin TE-1337 describes maker's high-

a new approach to the problems of instrumentation



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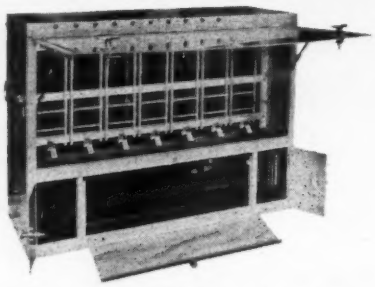

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NEW LITERATURE

current silicon power rectifiers. Two new 2-page sheets describe high-frequency silicon bonded diodes and high-conductance silicon junction diodes.—Transitron Electronic Corp., Melrose 76, Mass.

Circle **640** on inquiry card.

Transistorized Power Supplies. New 8-page brochure presents maker's complete line of transistorized and tubeless equipment such as power supplies, test equipment, etc.— Electronic Research Associates, Inc., 67 East Centre St., Nutley 10, N. J.

Circle **641** on inquiry card.

Power Supplies. New 8-page Bulletin CV-235 presents maker's constant voltage dc power supplies.—Sola Electric Co., 4633 West 16th St., Chicago 50, Ill.

Circle **642** on inquiry card.

DC Power Supply. New 2-page leaflet TDS-503 describes maker's 5000-volt dc power supply Model 503.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Circle **643** on inquiry card.

Power Supply. New 2-page bulletin describes maker's regulated power supply with positive, continuously variable output of 0 to 500 vdc at 200 ma. —Oltronix, 235 Underwood Drive, Atlanta 5, Ga.

Circle **644** on inquiry card.

RESISTORS, POTENTIOMETERS

Resistors. New 2-page Data Sheet EB2 (2) presents maker's adjustable dc resistors.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **645** on inquiry card.

Potentiometer. New 2-page Data Sheet 54-44 illustrates and describes maker's 1-7/16" diameter "Series 5400" precision potentiometer for servo or bushing mounting.—Helipot Technical Information Service, Newport Beach, Calif.

Circle **646** on inquiry card.

Potentiometers. New 2-page Bulletin 207/6/H presents specifications on maker's "Model 207 Hi-R Trimpot" and "Model 208 Hi-R TrimR".—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

Circle **647** on inquiry card.

Precision Potentiometer. New 2-page Data Sheet 54-66 illustrates and presents specifications on maker's 3" diameter "Series 5700" precision potentiometer.—Helipot Technical Information Service, Newport Beach, Calif.

Circle **648** on inquiry card.

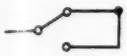
Potentiometers. Three new 2-page bulletins present maker's "Type 1410", "Type TM-10", and "Type TS-10" helical potentiometers.—Van Dyke Textigraph Co., Inc., 23 W. 2nd St., Chattanooga, Tenn.

Circle **649** on inquiry card.

Fuse Resistor. New 2-page Bulletin P-3 presents data on applications, design, ranges, tolerance, etc. on maker's "Type FR" fuse resistor.—

International Resistance Co., 401 N. Broad St., Phil. 8, Pa.
Circle **650** on inquiry card.

Resistors. New 4-page Bulletin B-9a presents maker's line of molded deposited carbon resistors. New 4-page Bulletin B-8b presents molded boron-carbon resistors. New 4-page Bulletin B-4b presents maker's 1/2, 1, and 2 watt deposited carbon precision resistors.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.
Circle **651** on inquiry card.



SWITCHES, RELAYS

Switches. New 4-page issue "Uses Unlimited" (Vol. 10, No. 2) describes pushbutton, toggle, and snap-acting switches.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.
Circle **652** on inquiry card.

Switches, Relays. New 2-page "Cook Diaphlex Newsletter" (Vol. 1, No. 30) presents specifications on maker's hermetically sealed voltage-standard, acceleration switch, and relay.—Cook Electric Co., 2700 No. Southport Ave., Chicago 14, Ill.
Circle **653** on inquiry card.

Toggle Switches. New 2-page bulletin presents data on maker's subminiature toggle switches.—Miniature Switch Corp., 3610 Oceanside Rd., Oceanside, L. I., N. Y.
Circle **654** on inquiry card.

WIRE, CONNECTORS

Electrical Wire Terminals. New 36-page "Adventures of Grandpa Champ," a hardbound well-illustrated booklet, humorously treats dangers of improper handling of electrical wiring, presents applications of maker's terminals, and lists rules for general electrical safety.—Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Penna.
Circle **655** on inquiry card.

Printed Circuit Receptacles. New 2-page Bulletin 44 presents maker's printed circuit receptacles and connectors.—Microdot, Inc., 1826 Fremont Ave., South Pasadena, Calif.
Circle **656** on inquiry card.

Wire. New 100-page catalog (replaces Oct. 1954 edition) presents maker's alloy, clad, and plated wire & ribbon, also weld and "Carbostrip" products. New 12-page booklet describes manufacturing facilities and tabulates compositions of various wires and ribbon.—Sylvania Electric Products, Inc., 12 Second Ave., Warren, Penna.
Circle **657** on inquiry card.

TRANSISTORS

Transistors. Two new 4-page Bulletins ECG-144 and ECG-153 present specifications on maker's new PNP junction transistors. Includes 2-page Specification Sheet ECG-109.—General Electric Co., Electronics Park, Syracuse, N. Y.
Circle **658** on inquiry card.

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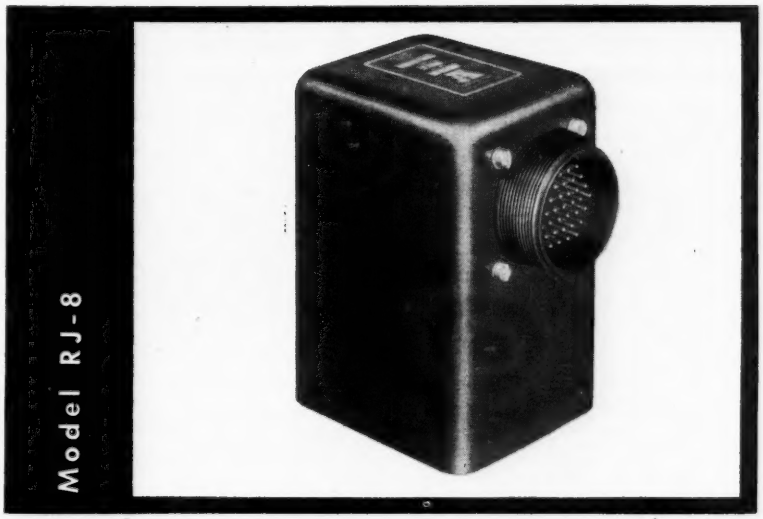

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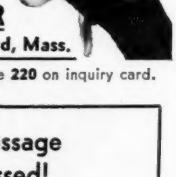

Tensitron, Inc., Harvard, Mass.

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NEW LITERATURE

MECHANICAL AND ELECTROMECHANICAL COMPONENTS

Set Screws. New 6-page Bulletin DM 723 presents theory and applications of multiple-spline socket screws.—The Bristol Co., Waterbury 20, Conn.

Circle **659** on inquiry card.

Variable Speed Drive. New 8-page Bulletin 521 pictures and describes maker's variable speed drive.—Graham Transmissions, Inc., Menomonee Falls, Wis.

Circle **660** on inquiry card.

Bearings. New 32-page Bulletin AFB-1 describes and illustrates maker's special-application anti-friction bearings.—Industrial Tectonics, Inc., 3686 Jackson Rd., Ann Arbor, Mich.

Circle **661** on inquiry card.

Motor Pulleys. New 8-page Bulletin V-563 describes maker's "Series 800" "Reeves Jr." variable speed motor pulleys.—Reeves Pulley Co., 1225 Seventh St., Columbus, Ind.

Circle **662** on inquiry card.

Bellows. New 20-page Catalog 155 is design guide for application and selection of metallic bellows.—Flexonics Corp., 1337 S. Third Ave., Maywood, Ill.

Circle **663** on inquiry card.

Grooved Fasteners. New 24-page catalog describes maker's line of "Driv-Lok" grooved fasteners; used also as linkage pins, anchors, etc.—Driv-Lok Pin Co., Sycamore, Ill.

Circle **664** on inquiry card.

Slip Ring Assemblies. New 4-page bulletin describes and illustrates maker's slip ring assemblies and commutators for gyroscopes, motors, resolvers, etc.—Slip Ring Company of America, 12820 Venice Blvd., Los Angeles 66, Calif.

Circle **665** on inquiry card.

Torque Gages. New 4-page bulletin describes maker's six models of "Torque-Watch" dial-reading gages for measuring extremely low-torque on potentiometers, servo mechanism, gear trains, etc.—Waters Mfg., Inc., P. O. 368, So. Sudbury, Mass.

Circle **666** on inquiry card.

TUBING, FITTINGS

Tube Fittings. New 12-page Catalog 4324 lists maker's "Intru-lok" flareless tube fittings providing tube entry and connection without fitting disassembly.—Tube and Hose Fittings Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **667** on inquiry card.

Cabled Tubes. New 12-page Bulletin 356 describes and tabulates maker's cabled tubes used for instruments and controls.—Crescent Insulated Wire & Cable Co., Trenton 5, N. J.

Circle **668** on inquiry card.

Super-Pressure Tubing. New 6-page Data Memorandum #22 presents maker's single and composite-wall tubing for pressures up to 100,000 psig. Includes table for minimum bursting pressures for single heavy wall tubing. —Superior Tube Co., 1564 Germantown Ave., Norristown, Pa.

Circle **669** on inquiry card.

Fittings and Flanges. New 4-page Data Card TDC-186 tabulates ASTM specifications of tubular products fittings and flanges in various grades of steel.—Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

Circle **670** on inquiry card.

Fittings, Flanges. New 6-page Bulletin FB-502 describes maker's line of carbon, alloy and stainless steel seamless welding fittings and forged steel flanges.—Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

Circle **671** on inquiry card.

Plastic Tube and Rod Stock. New 24-page catalog presents data and prices on maker's plastic rod and tube stock—Friedrich & Dimmock, Inc., Lincoln Ave., Millville, N. J.

Circle **672** on inquiry card.

Laminated Tubing. New 2-page Data Sheet 221 pictures maker's "Poro-Tube" laminated tubing.—Lamtex Industries, Inc., 51 State St., Westbury, L. I., N. Y.

Circle **673** on inquiry card.

MATERIALS

Phenolic Compounds. New 4-page Bulletin CDC-326 presents maker's black and brown general-purpose phenolic compounds.—Chemical Materials Dept., General Electric, Pittsfield, Mass.

Circle **674** on inquiry card.

Insulating Tape. New 4-page illustrated Brochure CCD-1 describes maker's "Irrathene" irradiated polyethylene insulating tape for motor repair shops.—General Electric Co., One Plastics Ave., Pittsfield, Mass.

Circle **675** on inquiry card.

Plastics. New 6-page folder lists plastics for electronics, including casting resins, foams, microwave absorbers, rod and sheet.—Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle **676** on inquiry card.

Bondable Teflon, Rulon. Three new bulletins present data on bondability of Teflon and Rulon in tape, film, rod, sheet or welded form.—Dixon Corp., Bristol, R. I.

Circle **677** on inquiry card.

Non-Woven Felts. New 14-page Bulletin D-78 presents data on properties of maker's non-woven felts of 100% dacron.—E. I. DuPont de Nemours & Co., Inc., Textile Fibres Dept., Wilmington, Dela.

Circle **678** on inquiry card.

Electrical Insulation. New 16-page booklet presents information on

What's in store for you at the 3rd INTERNATIONAL AUTOMATION EXPOSITION

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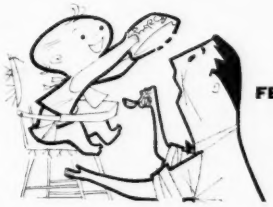
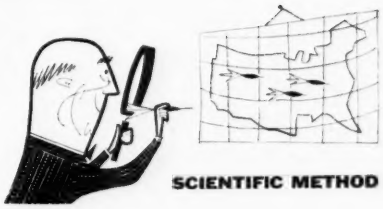


FEEDBACK



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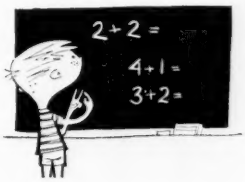

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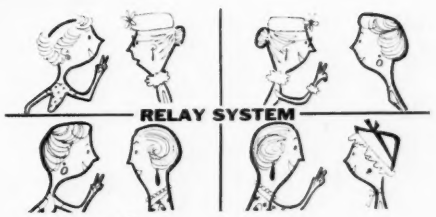

RELAY SYSTEM

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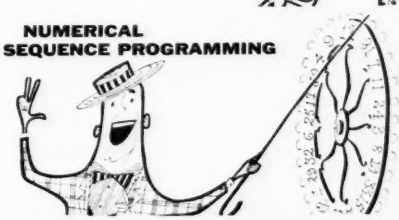

Your personal invitation is on page 1951

For clinic information see pages 1970-1971 or write, phone or wire

Richard Rimbach Associates
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NEW LITERATURE

maker's "Isomica" molding, segment, heater and flexible plates; tapes, flexible combinations, tubes and capacitor grade material.—Mica Insulator Co., P. O. Box 1076, Schenectady 1, N. Y.
Circle **679** on inquiry card.

Cellulose Wadding. New 8-page bulletin describes maker's "Cel-Fibe" cellulose wadding.—Cel-Fibe Div., Personal Products Corp., Milltown, N. J.
Circle **680** on inquiry card.

Stress Analysis Material. New technical data sheets describe maker's "Hysol 6000-OP" used fo rthree-dimensional photoelastic studies. Includes 4-page Price List 6000 OP.—Houghton Labs., Inc., Olean, N. Y.
Circle **681** on inquiry card.

Coated Fabrics. New bulletin 2-page Data Sheet presents specifications on maker's "Kel-F" elastomer coated fabrics.—Connecticut Hard Rubber Co., New Haven 9, Conn.
Circle **682** on inquiry card.

FABRICATION

Production Facilities. New 32-page illustrated bulletin describes operations of Mallory's Capacitor, Resistor, Switch, Vibrator, Welding Depts., etc.—P. R. Mallory & Co., Inc., Indianapolis 6, Ind.
Circle **683** on inquiry card.

Gas Producers. New 4-page Brochure GEC-1391 presents data on maker's "Thermalene" endothermic gas producers for production of protective atmosphere gases for heat treating.—General Electric Co., Schenectady 5, N. Y.
Circle **684** on inquiry card.

Molds for Plastics. New 4-page instruction leaflet explaining composition and uses of mold preparation materials for phenolic resins and epoxy resins.—Marblette Corp., 37-31 Thirtieth St., Long Island City 1, N. Y.
Circle **685** on inquiry card.

Rotary Cutting Tools. New 8-page bulletin "Golden Circle Rotary Tools" presents maker's line of ground cutters, rotary files, miniature cutters, etc.—Elgin National Watch Co., Elgin, Ill.
Circle **686** on inquiry card.

Welding Equipment. New 16-page Catalog 2-100 describes and illustrates maker's welding heads, power supplies, all-electronic control units, etc.—Raytheon Manufacturing Co., Dept. 6120, Waltham 54, Mass.
Circle **687** on inquiry card.

Protective Coatings. New 4-page illustrated Bulletin 656 describes maker's line of "Thermo-Cote N-4" strippable protective coatings.—Bischoff Chemical Corp., Ivoryton, Conn.
Circle **688** on inquiry card.

Coating Materials. New 6-page folder illustrates maker's "Turcoat" line of phosphating and metal protective coating materials.—Turco Products, Inc., 6135 So. Central Ave., Los Angeles 1, Calif.
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Readers' Inquiry Card

For further details on products reported in

- **Advertisements**
- **New Instruments**
- **Briefs**
- **New Literature**

circle the number

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INSTRUMENTS and AUTOMATION

Oct. '56

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Name ..... Title .....

Company .....

Company Address ..... City..... Zone..... State.....

Products Manufactured.....

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Advertised Products

1	26	51	76	101	126	151	176	201
2	27	52	77	102	127	152	177	202
3	28	53	78	103	128	153	178	203
4	29	54	79	104	129	154	179	204
5	30	55	80	105	130	155	180	205
6	31	56	81	106	131	156	181	206
7	32	57	82	107	132	157	182	20.
8	33	58	83	108	133	158	183	208
9	34	59	84	109	134	159	184	209
10	35	60	85	110	135	160	185	210
11	36	61	86	111	136	161	186	211
12	37	62	87	112	137	162	187	212
13	38	63	88	113	138	163	188	213
14	39	64	89	114	139	164	189	214
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23	48	73	98	123	148	173	198	
24	49	74	99	124	149	174	199	
25	50	75	100	125	150	175	200	

New Instruments

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302	327	352	377	402	427	452	477
303	328	353	378	403	428	453	478
304	329	354	379	404	429	454	479
305	330	355	380	405	430	455	480
306	331	356	381	406	431	456	
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New Literature

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507	532	557	582	607	632	657	682	
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514	539	564	589	614	639	664	689	
515	540	565	590	615	640	665	690	
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521	546	571	596	621	646	671	696	
522	547	572	597	622	647	672	697	
523	548	573	598	623	648	673	698	
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523	548	573	598	623	648	673	698	
524	549	574	599	624	649	674	699	
525	550	575	600	625	650	675	700	

NEW LITERATURE

Surface Plate Calibration. New bulletin features article on "How to Calibrate Surface Plates in your Plant."—Collins Microflat Co., 2326 E. 8th St., Los Angeles 21, Calif.

Circle **690** on inquiry card.

Boring Heads. New 12-page Catalog 6B presents maker's six standard precision boring heads and patented adjusting principle for close tolerance boring.—Briney Mfg. Co., P. O. Box 2208, Pontiac, Mich.

Circle **691** on inquiry card.

Brass Forgings. New 32-page Catalog (Aug. 56) presents design, properties, and applications of maker's brass, bronze and aluminum hot-pressed forgings.—Titan Metal Manufacturing Co., Bellefonte, Penna.

Circle **692** on inquiry card.

Forgings, Castings. New 32-page Catalog FC4-Ed3 presents data on smooth hammered forgings, composite die sections, cast-to-shape tool steels, etc.—Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Penna.

Circle **693** on inquiry card.

Selenium Rectifiers. New 2-page information sheet pictures and describes maker's air-cooled selenium rectifiers for cathodic protection against corrosion.—Corrosion Services, Inc., P. O. Box 7343, Tulsa, Okla.

Circle **694** on inquiry card.

Aluminum Handbook. New 176-page handbook tabulates and describes aluminum products in all its forms from wrought alloys, sheet, plate, wire, rod, bar, extrusions, tube and pipe, to casting alloys.—Aluminum Company of America, 1501 Alcoa Building, Pittsburgh 19, Pa.

Circle **695** on inquiry card.

Lathe Centers. New 18-page illustrated Catalog CD-56 on maker's line of "Red-E" cylindrical grinding machine, lathe centers, and grinder dogs. —Ready Tool Co., 554 Iranistan Ave., Bridgeport 5, Conn.

Circle **696** on inquiry card.

MISCELLANEOUS

Drafting Room Aids. New 6-page folder describes maker's "Stanpatches" and "Stanpatch" cellulose acetate tapes for repairing tracings, drawings, blueprints, etc.—Stanpat, Whitestone 57, N. Y.

Circle **697** on inquiry card.

Work Benches and Accessories. Three new 2-data sheets describe maker's work center accessories; 6, 8 and 10 position work centers; work center benches, etc.—Alden System Co., Alden Res. Center, Westboro, Mass.

Circle **698** on inquiry card.

Hard Rubber Products. New 4-page Brochure E285 presents application and characteristics charts and technical molding tolerances of maker's hard and resin rubbers.—Stokes Molded Products Div. of Electric Storage Battery Co., Taylor at Webster Sts., Trenton 4, N. J.

Circle **699** on inquiry card.

Batteries. New 6-page folder Form 5916 describes maker's line of Exide-Manchex batteries used for stationary power services.—Exide Industrial Div., Electric Storage Battery Co., Box 8109, Phila. 1, Pa.

Circle **700** on inquiry card.

Homogenizer-Mixer. New 8-page Catalog 402-R-2 describes maker's high-speed, high-shear homogenizer-mixer for blending and homogenizing of paints, pharmaceuticals, cosmetics, heavy chemicals, etc.—Gifford-Wood Co., Graybar Bldg., New York, N. Y.

Circle **701** on inquiry card.

Nameplates. New 2-page bulletin presents maker's "Namettes" specially-styled nameplates.—Berglund-Swenson Co., Inc., 554 Elm St., Arlington, N. J.

Circle **702** on inquiry card.

Electronics Handbook. New 64-page Electronics Data Handbook presents collection of formulas and data used in radio and industrial electronics. —Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle **703** on inquiry card.

Chemical Containers. New 8-page bulletin presents maker's standard and custom "Agilene" corrosion-proof tanks and containers.—American Agile Corp., P. O. Box 168, Bedford, Ohio.

Circle **704** on inquiry card.

Radiochemicals. New 22-page catalog presents maker's radioactive materials available from stock.— New England Nuclear Corp., 575 Albany St., Boston, Mass.

Circle **705** on inquiry card.

Ultrasonic Cleaner. New 2-page Bulletin S-10 presents maker's new, small, ultrasonic cleaning apparatus for bench-top washing of delicate, intricate parts that must be "surgically" clean.—Branson Ultrasonic Corp., 37 Brown House Road, Stamford, Conn.

Circle **706** on inquiry card.

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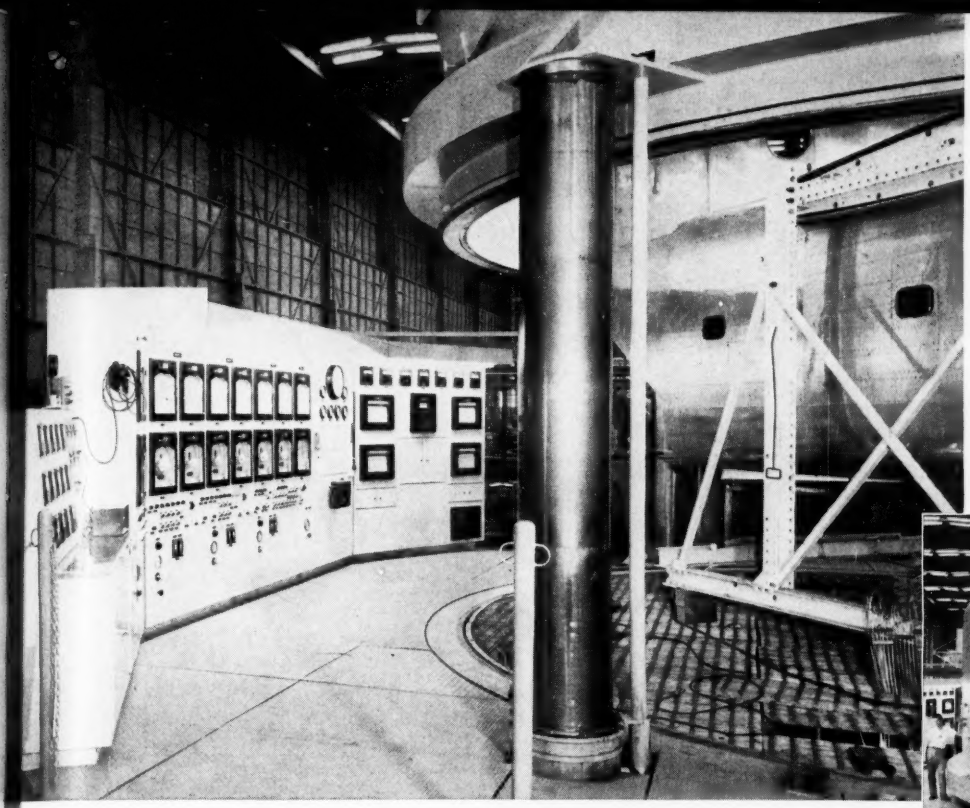

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